consulting engineer

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. . . maintaining a tradition

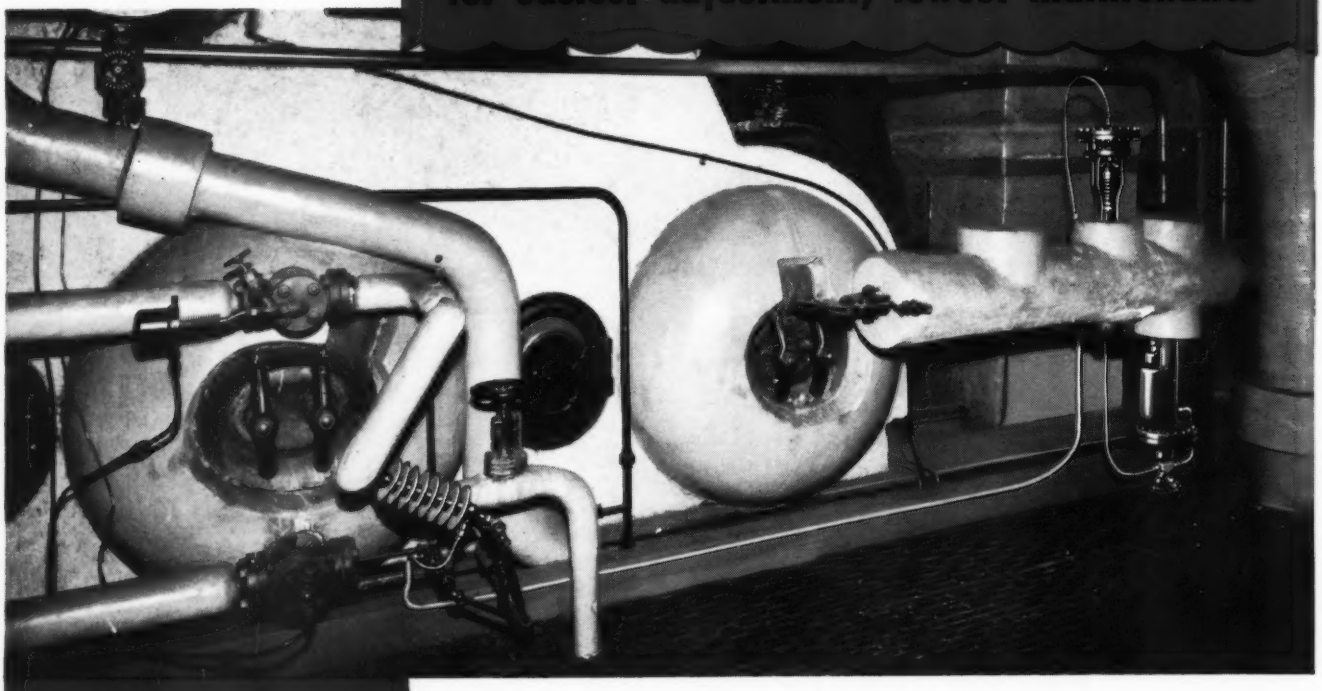
Team Quarterback

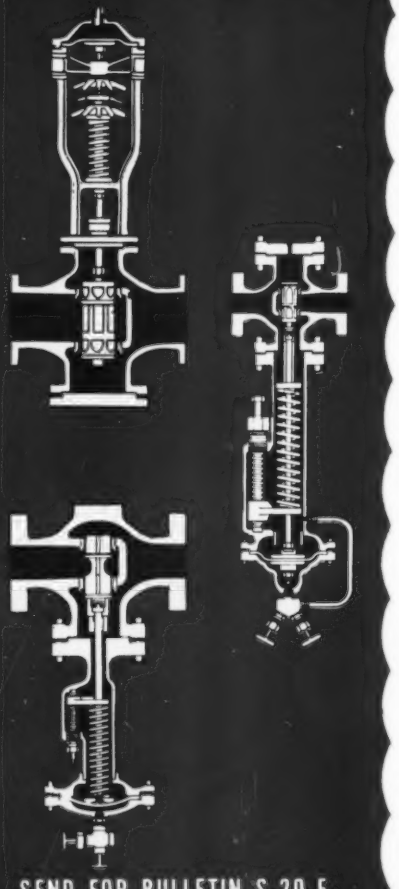
GEORGE H. MIEHLS is the combination quarterback and team captain for the Albert Kahn organization. Chosen by his teammates to call signals, he knows the plays, the players, and the game from the ground up. But calling signals at Albert Kahn is not just a matter of barking numbers or orders

—Continued on page 7

Swartwout SC Type FW1 Feed Water Regulators

for easiest adjustment, lowest maintenance





1 **SWARTWOUT SC TYPE FW1** feed water control system consists of thermo-hydraulic generator and regulating valve. Generator piping is a self contained support; no brackets are required. Moving parts are reduced to a minimum. Since there are no floats, levers, turnbuckles or pulleys to line up, regulator valve may be located anywhere. Another plus feature is that speed and degree of generator response can be quickly, easily changed without special tools, cutting or welding.

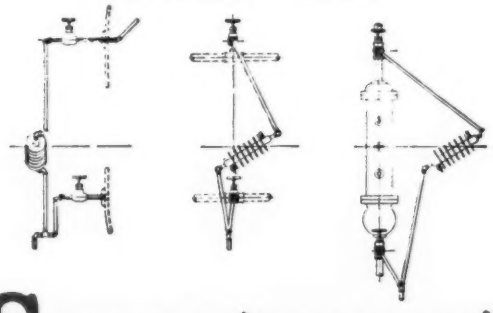
2 **FW1 REGULATING VALVE** is of balanced, tight seating type ruggedly constructed. Long life V-type stem packings. Diaphragm is molded of special rubber with four plys of cord fabric, moves from closed to open position without any stretch imposed on it.

3 **SL DIFFERENTIAL PRESSURE VALVE** can be used with Swartwout FW1 Feed Water Regulators to smooth out erratic feed water pressures. Stainless steel disc, seat, and stem and special formula molded rubber diaphragm.

4 **TYPE A DIFFERENTIAL PUMP GOVERNOR** can be used with FW1 regulating systems to maintain required pump discharge pressure. No stuffing box on moving parts; easy screw type adjustment.

A-8481

TYPICAL GENERATOR INSTALLATIONS



Swartwout

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PROCESS INDUSTRY CONTROLS
INDUSTRIAL VENTILATION

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VOLUME 3
NUMBER 1

consulting engineer

Published by
Industry and Power Publications

JANUARY 1954

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The Engineering Index Service in Public Libraries lists articles from CONSULTING ENGINEER.

Publisher, E. R. Gauley
Production Manager, F. C. Donohue
Circulation Manager, John B. Klein

Representatives: See addresses p 82
New York; Newark, N.J.; Chicago
Philadelphia; Cleveland
Los Angeles

CONSULTING ENGINEER is published monthly at 420 Main Street, St. Joseph, Mich. Subscription one year $5.00; outside U. S. price is $10.00; single copy 50 cents. Acceptance under Section 34.64 P. L. & R. authorized by U. S. Post Office. Form 3547 requested. Copyright 1954 Industry and Power Publishing Company.

IT WAS A LONG MEETING
–and all we talked about was ash

Yes, gentlemen, we know what you mean. Ash from burning coal is on the agenda of many meetings today —meetings of industrial and utility power-plant operators, air-pollution control boards, and civic-minded groups.

And when you're running a big power plant whose boilers consume many tons of coal every hour, ash disposal becomes a serious problem for discussion. You must talk about the high cost of equipment to trap fly-ash before it leaves the stack . . . the expense of paying for carting away tons and tons of this waste . . . and, of course, how to get the most out of the coals you buy, even if their ash content is high.

These and related problems have plagued industrial and utility power-plant men for years, the more so because they have a keen sense of responsibility for keeping their cities clean, and they are determined to keep operating costs down not only in their own interest but also that of the public.

We would like to make a suggestion. Put B&W's Cyclone Furnace on the agenda for your next meeting . . . and the day you put the Cyclone on your firing aisle you'll start enjoying advantages more and more power-plant men are discussing.

This more efficient method of burning coal converts most of the ash to molten slag, which drains continuously into a water pit for disposal.

If need be, the small amount of fly-ash remaining in the stack gases can be trapped by simple, inexpensive ash collectors and then returned to the Cyclone Furnace to be melted into slag. Result: Elimination of air pollution and of the costly mess of fly-ash disposal.

The Cyclone has many other advantages of interest—increased combustion efficiency, greater fuel flexibility, increased safety, and easier operation.

All this is accomplished—and is being proved in daily service—with *less equipment, less building volume, less manual labor,* and *less maintenance* than is possible when pulverized coal is used. For the Cyclone Furnace is a vast simplification of the entire process of coal preparation, combustion, ash segregation, and ash handling, which brings important savings right down the line.

Selected to fire some of the world's largest and most efficient boilers, Cyclone Furnaces are in operation—under a variety of operating conditions—in different parts of the country. Based on this intensive, long-range experience, we will be pleased to discuss the advantages which the Cyclone Furnace offers.

BABCOCK & WILCOX
BOILER DIVISION

N-166

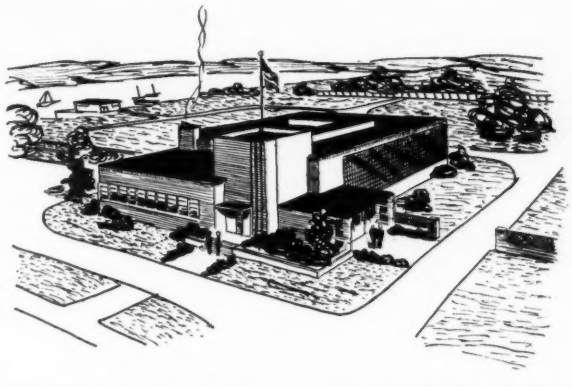
Team Quarterback

—*Starts on Front Cover*

at creative architects and engineers who can often be like "prima donnas". Blending these creative and imaginative talents with tested business practices; watching the dollars and cents—which after all depend not only upon original ideas but on a certain amount of production; maintaining a past tradition in terms of the present; is what George Miehls was selected to do by his associates in 1945.

To fully comprehend Miehls' position and to appreciate his job, one must know something of the Albert Kahn organization. Founded more than 50 years ago by Albert Kahn, it had been continuously under family management until the last of the five brothers died in 1945.

The Kahn organization attributes its successful operation to adherence to the principles of service to the client. Recognizing that the organization is based on service, they have assumed the full responsibilities, while at the same time limiting their functions to those in which they are most proficient—design and construction supervision of industrial, commercial, and institutional buildings.



During the years, this principle has literally grown to a dedication of purpose. It is against this background that the client can confidently tell the Albert Kahn men what he wants, trust their judgment to properly study and evaluate all the factors, and rely upon them to prudently spend his money.

Many people buy only one house in a lifetime and many firms build only one plant in a corresponding period of years. The decision to build is an important one, dominated by the knowledge that the structure is more or less permanent and that it will stand as a monument (or a "white elephant") for all to see.

With this in mind, Albert Kahn set a second early precedent for the organization. Sound and proven architectural and engineering principles and methods were incorporated in their designs. The functional plan dictated the esthetics of the exterior. The firm has pioneered many radical departures from the conventional, but such departures have been analytically sound and thoroughly tested before being embodied in the final design.

The third emphasis has been on teamwork. Rewarding loyalty and proven abilities by making his key men associates in the firm, Albert Kahn succeeded in doing several things.

The organization represents the collective ideas, judgment and experience of many men.

A pattern for continuity of the firm has been set—no single man is indispensable—so that it can function successfully for an indefinite period.

By sharing in the profits as well as the management of the firm, Albert Kahn provided the necessary incentives and stimuli to bring out the best in the professional growth of his men.

George Miehls entered this pattern in 1919, two years after he was graduated from Ohio State University with his B. S. in civil engineering. As a structural engineer he first saw many of Kahn's most prominent jobs over a T-square and drafting board.

During the war years Albert Kahn helped the government design and lay out military bases and emergency production facilities. Miehls, first as structural engineer and later as project manager, was in large measure responsible for developing the Curtiss-Wright projects, the largest mass-production airplane plants ever built up to that time. Later in the war, he was one of the group of Kahn engineers engaged in the study of the production requirements of Consolidated's B-24 "Liberator" prior to designing and laying out Willow Run.

His years of active participation in the engineering and design work were now coming to a close, and a new phase in his career opened. With his election as a vice-president of the Kahn firm, Miehls assumed the role of an administrator. Eighteen months later he was made executive vice-president. And when the last of the Kahn brothers died in 1945, his associates, both senior and junior, gave him their vote of confidence to guide the firm as president.

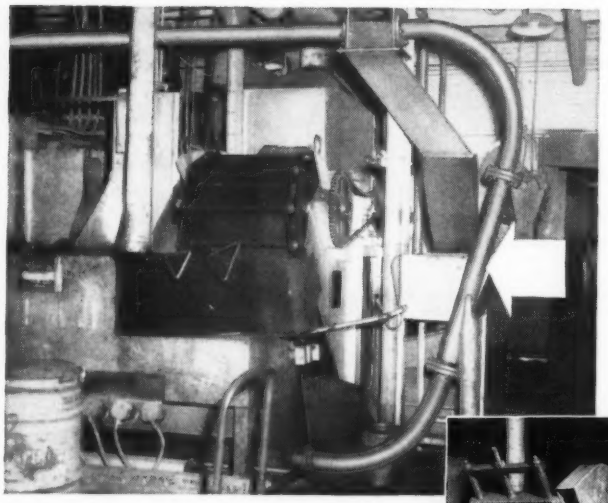
Under his leadership, the Albert Kahn firm has continued to hold its place as one of the top in the profession. A part of its contribution to the post-war expansion of the nation's industrial plant includes assembly facilities for most of the large automotive concerns; manufacturing plants for aircraft companies like Pratt & Whitney and Sikorsky; newspaper plants for the Philadelphia Inquirer, Washington Post and Gannett Newspapers; laboratories for Procter and Gamble and International Harvester.

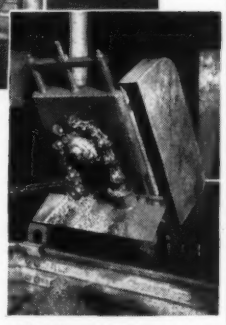
A fitting tribute to the man's abilities is found in the statement made when George Miehls received an honorary membership in the Michigan Society of Architects, "in recognition of his distinguished service in the fields of engineering, building, and particularly to architecture and the allied arts."

HERE'S HELP!

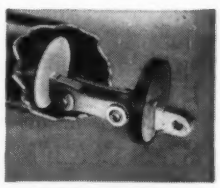
HANDLE "HOT JOBS" with Hapman TUBULAR CONVEYORS

and save money too!





Chip-handling conveyor will remove chips from coolant.



Cross section showing Sealed-Pin Chain and Neoprene Flights.

THREE MAN-DAYS AND EIGHT HOURS of valuable production time every month were formerly lost in removing scale from the quench tank at Bower Roller Bearing Co., Detroit. An unpleasant job, too!

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SCRAPS & SHAVINGS

THE PROFESSIONAL Engineers Conference Board for Industry has just completed an excellent report which is now being published by the National Society of Professional Engineers. The subject is "How to Attract and Hold Engineering Talent." It deals primarily with the professional engineers employed by manufacturing plants, but it also includes engineers in consulting firms as well as in other types of engineering employment. The report is based on a survey, and the answers which were given to two of the questions should be interesting to consultants.

Last month we carried an article, "Nobody Wants to be a Draftsman," which was prepared when we found that many consultants were having trouble holding good men in their drafting rooms. We know that some firms feel they also have too high a turnover even among the engineering personnel. However, if the results of this Conference Board survey are accurate, consulting firms should have less trouble getting and holding good men than any other type of engineering employer.

This survey showed that 78 percent of the engineers currently employed intended to change jobs at some future time. When they do, they want to go into consulting work. That is, more of them are interested in becoming consultants than in going into any other single field. A total of 31 percent of those who plan to change indicated that they want to become consultants.

If we make some rough calculations we can estimate that 75,000 engineers who are now employed in other fields intend to become consultants. Since there are only some 18,000 engineers currently engaged in private practice, this means that there are at least four men who wish they were consultants for every man who now is one.

Prestige is extremely important. Equally attractive is the excellent chance for financial success. It is well known that the consultant is the highest paid among engineers at the 25 year experience level. So long as consultants maintain their professional standing and stay at the top financially, finding and holding good, young engineering talent should be relatively easy. Perhaps "nobody wants to be a draftsman," but apparently "every engineer wants to be a consultant."

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Marley Application Engineers render expert assistance in evaluating the relative merits of *all* types of towers, for Marley builds all types. This service, invaluable to owners and operators alike, is yours without obligation. Use it freely. A staff of 150 Marley engineers in 50 cities stands ready now to show you how to save water — and save money.

MARLEY

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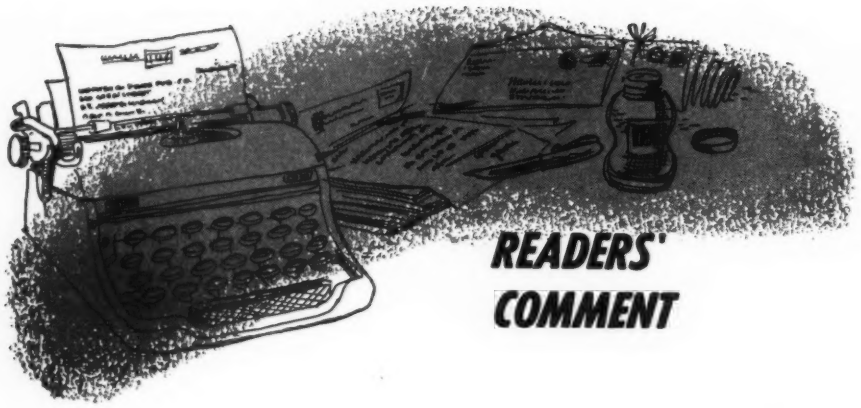
KANSAS CITY 5, MISSOURI



READERS' COMMENT

Received With Thanks

Sir:

You are to be congratulated on the character of the articles which you are publishing in CONSULTING ENGINEER. The wide range of subject matter which you are using is gratifying and gives a good picture of what is going on in the various engineering fields. I like the fact that you do not go into extreme detail so that the articles are kept of general interest and one is able to retain reading interest throughout the magazine.

I was especially interested in the article "Lighting for Industrial Inspection" on page 37 of your December issue. I am enclosing herewith a letter addressed to the authors of that article and I would appreciate it if you would forward to the proper address within the Westinghouse organization. Thank you for this courtesy.

I am looking forward to future issues of your interesting publication.

Ralph E. Meints
Project Engineer
Vern E. Alden Company
Chicago 2, Illinois

Sir:

Mr. Arthur Heiberg of Akron has shown me your column "Scraps and Shavings" which appeared in the October, 1953 issue of the magazine CONSULTING ENGINEER. Yours is a most thoughtful statement of the situation in which the national engineering bodies find themselves and of the problem which they must face inevitably in order that the profession may be unified. I was grateful for the opportunity to read it.

Charles P. Smith, President
Ohio Society of Professional Engineers
Columbus, Ohio

Sir:

I would like your permission to mimeograph and distribute among some of the fellow members of the Michigan Society of Professional Engineers the "Scraps & Shavings" article on page 16 of your October 1953 issue. Your magazine will, of course, be given credit for the article. May I have your permission?

H. N. Barnard
Cummins & Barnard, Inc.
Ann Arbor, Michigan

● GRANTED—ED

Sir:

While at our Richmond, Va. office I mentioned to our Mr. R. C. Conrad, Project Engineer, the very high merit of your "CONSULTING ENGINEER." He would like very much to be placed on your mailing list, and the writer would personally appreciate it very much if this could become a "fact accomplished."

Robt. N. Wagener
Mechanical Engineer
Wyatt C. Hedrick
Fort Worth 1, Texas

● FACT NOW ACCOMPLISHED—ED.

Dallas Scholarships

Sir:

The entire [Engineers Club of Dallas] particularly the Scholarship Committee, appreciates the publication of information (CE-Nov. '53) concerning our program. There was only one part that might have been amended, and I am explaining it now in the anticipation that other engineering societies may ask you more about this.

The purpose of the scholarships is to get boys started in engineering college, and to make them self-sufficient as rapidly as possible. In general, it takes about one and one-half years for a boy to establish himself with a company where he always has a summer job, and to line up a satisfactory part-time job at school. We were cautioned many times about giving boys sufficient money for all their expenses, and after much investigation decided that about 60 percent of their minimum needs was the ideal figure—along with arrangement for a full-

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America's leading manufacturers and utilities depend on
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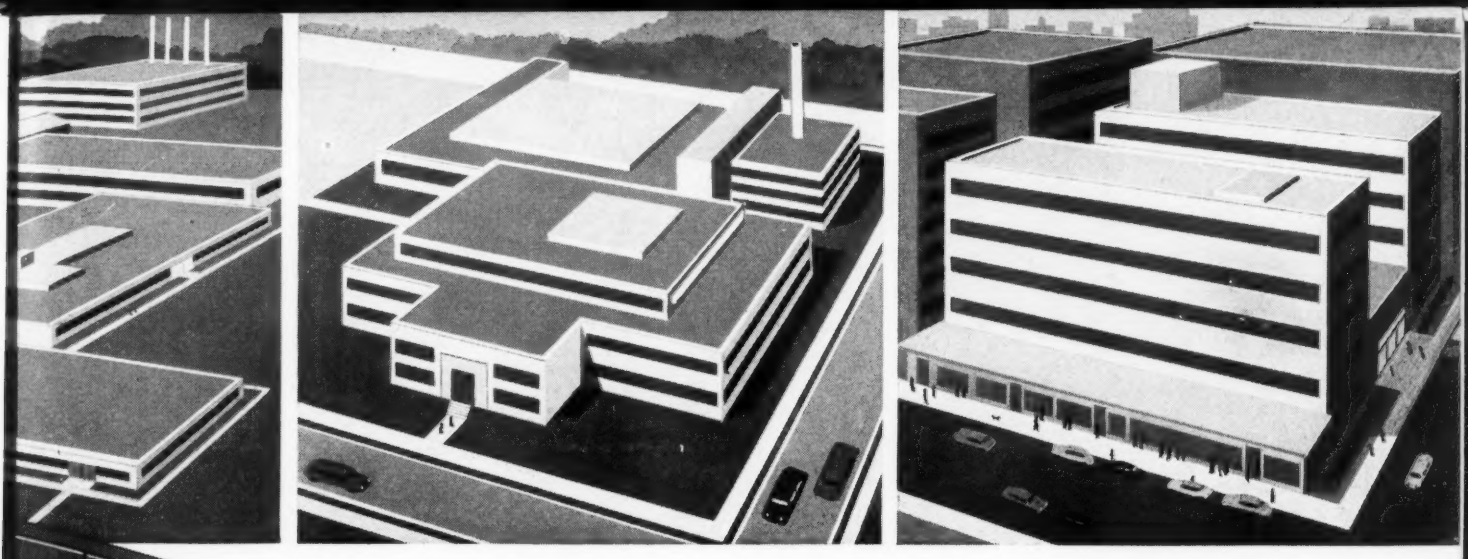
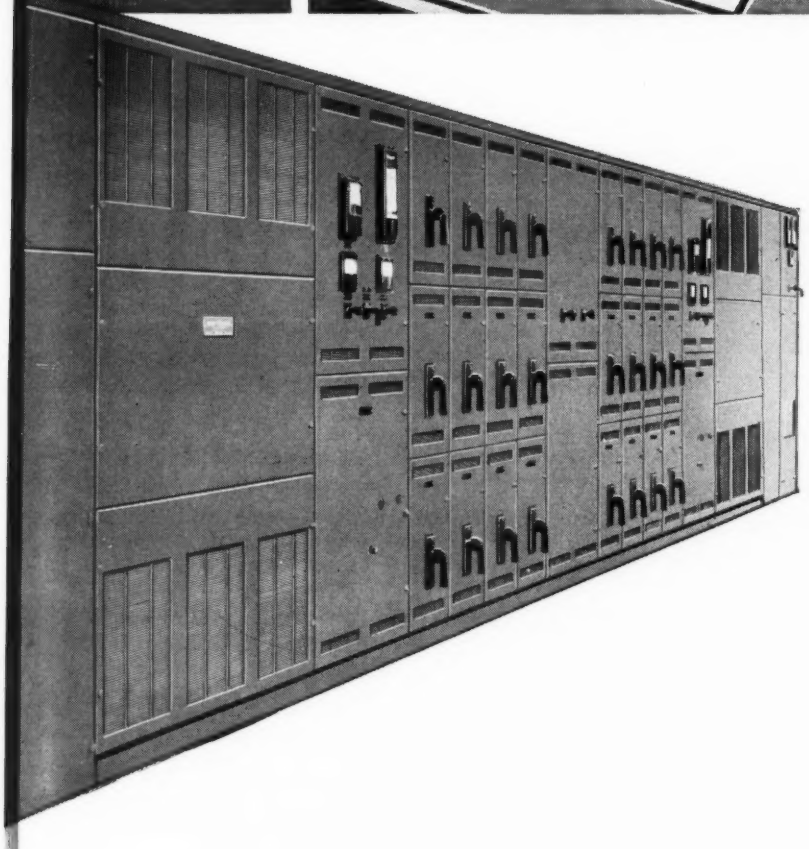
Thomas Strip Division Pittsburgh Steel Company





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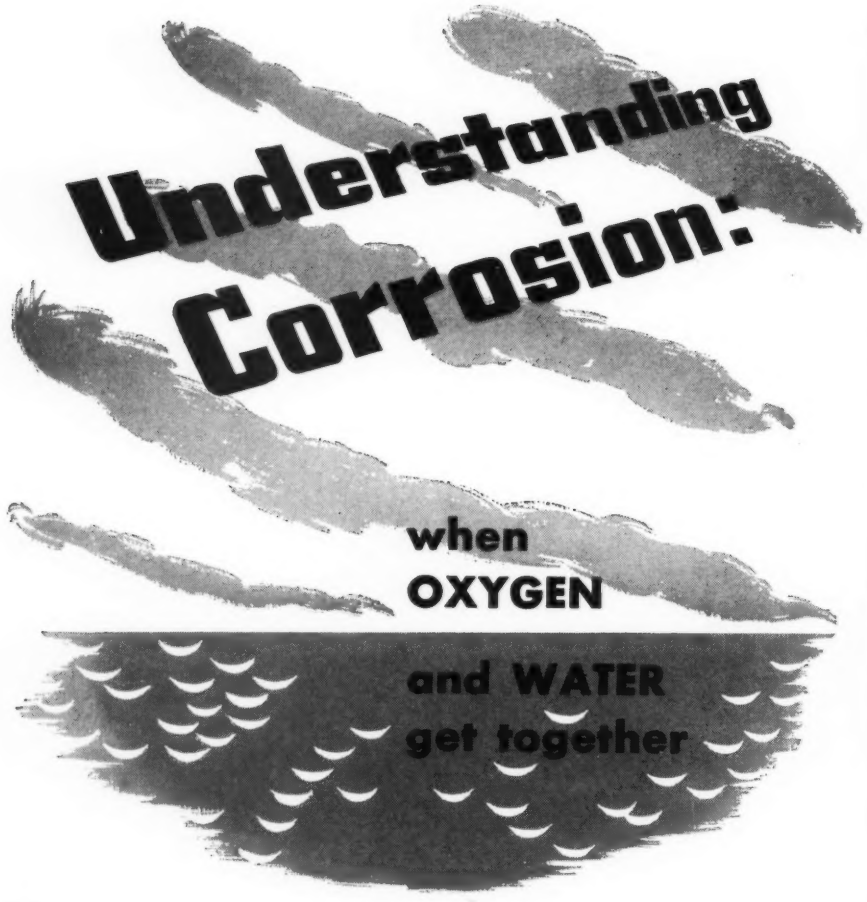
UNIT SUBSTATIONS



When free oxygen combines with atmospheric moisture or natural waters, the stage is well set for corrosive action. Controlling the degree and extent of that action are many related factors, variable in influence under differing circumstances.

The rate at which oxygen is transferred from atmosphere to a solution is, for example, directly proportional to the amount of exposed surface area of that solution, while the corrosion rate of immersed metal is, in turn, proportional to the oxygen concentration of the solution. Therefore, with all other factors stabilized, a reduction in exposed surface area will slow the oxygen-solution process, thereby greatly retarding corrosion.

How deeply metal is immersed, particularly in a quiet solution, is another determinant of corrosive action in which dissolved oxygen is the governing factor. Oxygen saturation, highest at and near the surface, diminishes with increasing depth as convection currents become less active. Corrosion at and immediately below the surface of a liquid is therefore far more severe than that encountered at greater depths.

These and other variables that combine to produce a given corrosion problem must be evaluated in any attempt to reach an effective and practical solution. Such evaluation, based on thirty-five years' corrosion-control experience, is standard Dampney procedure. That is why your specification of a Dampney Coating assures you so much *more* — protection you can depend upon to meet not only standard industrial service requirements but your specific equipment-operating needs. For data on Dampney Protective Coatings and their place in your corrosion-control program, write

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time summer job and part-time jobs at school to help them make up the other 40 per cent. Usually, by the end of the first semester of the sophomore year, the boys are able to carry the entire load.

Some of the high school seniors who graduate in February are able to save sufficient money to pay all of their first-year expenses, and continue to be self-sufficient without us ever contributing anything in the way of money. The mere fact that we are back of them to pull them out of a bad financial situation in case one develops seems to give them all the encouragement they need to go ahead on their own.

H. B. Renfro
Dallas 25, Texas

Unions Needed

Sir:

No, engineers are not being paid sufficiently for their contributions to industry, as a matter of fact they are receiving the least of all workers in consideration of the time and outlay required to master their vocation.

We feel that your suggestion (CE-Sept. '53) of more engineers going in for a fee basis is rather far-fetched.

After perhaps a much more conclusive investigation of the engineer and his problems than has been attempted otherwise, we feel that what is needed is not only a workable fee system but also an organization at least similar to a union, if not so-called.

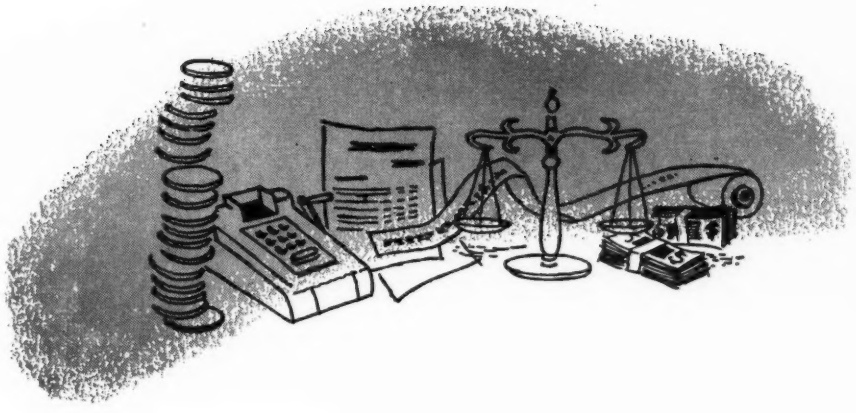
Some time ago there was the beginning of such an organization in the Federation of Architects, Engineers, Chemists and Technicians, but apparently this organization was unable to weather the opposition which unified industry brought to bear, and so it fell by the wayside somewhere. But at least someone had the right idea and we are looking forward to the day when an opportunity presents itself to join an active engineers union no matter what the title may be. Once a strong union is operating for engineers the day when industry will fail to give the engineer all consideration due him will soon pass.

You see, after being forceably given an opportunity to personally investigate the engineering employment situation first hand, much more thoroughly than any writer has ever attempted, we now really know and more completely understand what is really involved.

Clifford B. Bogle
Maryville, Tennessee

● FOR ANOTHER VIEWPOINT SEE PAGE 20 OF THIS ISSUE—ED

ECONOMIC NEWS NOTES



E. J. Mac Donald
INDUSTRIAL ECONOMIST

INDUSTRIAL EQUIPMENT—In an informative study, Machinery & Allied Products Institute shows that from 1900 to 1953, the index of hourly wage rates rose about 1,000 percent, cost of plant construction 540 percent, and equipment prices only 370 percent. Since "operations mix" generally permits considerable shifting of manual and machine operations, the gap between the relative price increases is a significant consideration for management and consulting engineers. MAPI points out that new plant and equipment are also interchangeable. "With plant abnormally expensive in relation to equipment, industry naturally tends to favor the latter, and has done so."

DEPRECIATION CHANGE—Among the important proposals on the tax-revision agenda of the House Ways and Means Committee is that to permit businesses to write off for tax purposes two-thirds of the cost of new capital assets during the first half of their economic life. Many revisions of tax treatment of depreciation have been proposed recently; some change to the advantage of business likely will be enacted.

PRICE STABILITY—Industrial property prices will be stable during the first six months of this year, according to a nation-wide survey by the National Association of Real Estate Boards. Only 11 percent of respondents reported looking for a rise in these prices. Industrial commodity prices, according to other reports, demonstrated no strong indications of firmness at the opening of this year and might develop weaknesses under stress of keen competitive marketing.

$900 MILLION LOSS—According to Mr. M. Braidech, research director, National Board of Fire Underwriters, fires cause destruction to almost 200 manufacturing and mercantile establishments every day. All told, there are over a million fires a year causing 11,000 deaths. The Board, in a preliminary estimate, set fire losses for 1953 at about $925 million.

SOUTHERN STORY—One of the "best sellers" currently is the story of industrial and market opportunities in the states below the Mason-Dixon Line. Among the many reports on the trek of manufacturers to southern locations is that of Mr. F. McKay, publisher in Nashville, who states that 45 percent of industry moving South is attracted by market opportunities and 30 percent by availability of materials. Only 25 percent joins the parade because of lower labor costs.

BIG BUSINESS—Research activities of American industries cost a pretty dollar—about three billion of them, according to surveys conducted by the Harvard Business School. It was found that 44 percent of all industrial companies each spent over $5,000 on research projects in 1952. Makers of laboratory and other scientific instruments had the highest ratio of research outlays to sales; furniture and food producers were at the foot of the scale. Detailed information from 191 companies showed that 50 percent of their outlays went for improvement of existing products or processes, 42 percent for creation of new lines and methods, and 8 percent for basic research not related to specific products or processes.

CONCENTRATION VS. DISPERSION—Businesses that invest at least $25,000 in "protective construction" to minimize enemy bomb damage to plants in primary target areas are entitled to 100 percent rapid tax amortization under a little-publicized policy of ODM. This is a dangerous procedure, according to Mr. L. Yaseen, Fantus Factory Locating Service, who holds that instead of encouraging further construction in congested vulnerable areas, ODM should push for at least partial decentralization of military production by utilizing plant facilities in rural areas.

BALANCED PERSPECTIVE—At the American Economic Association convention last month, predictions and forecasts were a dime a dozen—some of them worth it. There were, of course, many points worth consideration: (1) We are in a period of readjustment, sliding off peaks that were reached while the economy was under forced draft. Even a sizable decline from the record heights is likely to leave 1954 above all other years in our history except the last two. (2) Regardless of short-run declines, the long-run trend is still pointing upwards. (3) Among numerous factors of strength are growth of population, the biggest poke of individual savings in our peacetime history, capital-outlay planning by business on a long-term basis, and an insatiable list of needs by state and local governments. Troubles there may be this year, but they should be assessed against underlying trends and forces.

KEY FACTOR—It's one of those situations that looks as though it's trouble if you do and trouble if you don't. Various signals in recent months have indicated the advisability of inventory curtailment, and business in general has heeded the warnings. No one wants to get caught with excess stocks; that spells real trouble. Living off inventories, however, cuts down new orders and spells trouble for the other fellow—and for the whole economy before too long. The experts, in their turn-of-the-year forecasts, were betting that inventory adjustments would be effected fairly smoothly and would not work into a downward spiraling of orders, production, employment, and income of depression-like proportions.

ATOMS IN ACTION

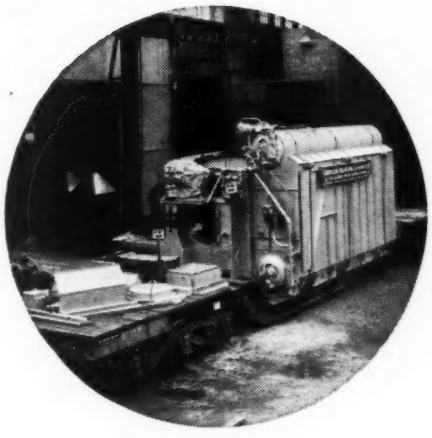
PRESIDENT EISENHOWER'S "atoms for peace" foreign policy statement was quickly followed up by a decision of the AIChE to form a Nuclear Engineering Division. William T. Nichols, AIChE president, said the new division would be composed of scientists and atomic production experts from practically all technical organizations involved in atomic energy. The group will co-sponsor a five-day Nuclear Engineering Congress on the University of Michigan's Ann Arbor campus beginning June 20; exchange of non-military information with atomic energy chief executives of several non-communist foreign nations is planned.

JOINING THE ACT are other groups swinging aboard the nuclear bandwagon. The Tennessee Valley Authority has just been authorized by the AEC to go ahead with a study of immediate and long-range possibilities for commercial nuclear power; this study will be similar in scope to others made by some private industrial groups (CE, July, 1953, p 28) which investigated economic and technical questions.

FRENCH INDUSTRY is also showing an awareness of the vast potentialities of coming atomic industrial era; two industrialists from France have just visited the United States under the auspices of Knapp Mills, Inc. as a further step in Knapp's plan to establish a world-wide patent pool on clad metals. The French were particularly interested in lead-clad metals which are playing an important part in atomic energy; they also inspected oil processing, aniline dye, metallurgical, chemical, and atomic energy equipment firms. According to Knapp Mills, the visit was predicated on the real necessity of translating to Europe and the Mediterranean areas the latest American techniques whereby any equipment related to the atomic and chemical process fields might be fully fabricated abroad without recourse to outside assistance.

A REPORT (see "Books"--p 81) just released by the Atomic Industrial Forum contains the up-to-the-minute thinking of many of the nation's best informed persons in atomic energy. In a panel discussion sponsored by the Forum, the following points were made by the experts: there is a clear need for economically competitive atomic power; it is virtually certain that nuclear reactor technology can be advanced to the point where atomic energy will be generally competitive; the years immediately ahead should be devoted to intensive development work; free enterprise should be permitted and encouraged to participate as widely as possible in introducing the advantages of the American competitive system into atomic energy (this in addition to government research and development which should be continued within limits); and the present government monopoly in atomic energy should be relaxed as soon as possible to permit private participation, with government control through regulation substituted for present government control through direct ownership and management.

By the car load...



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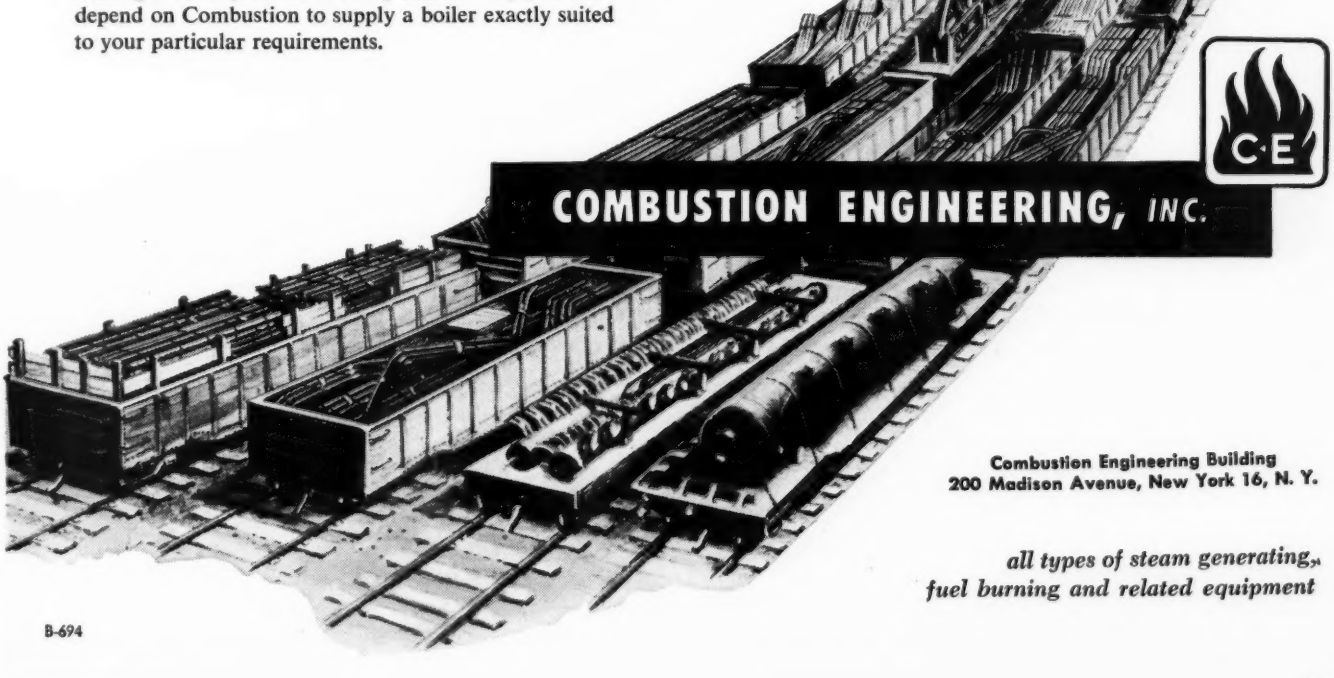

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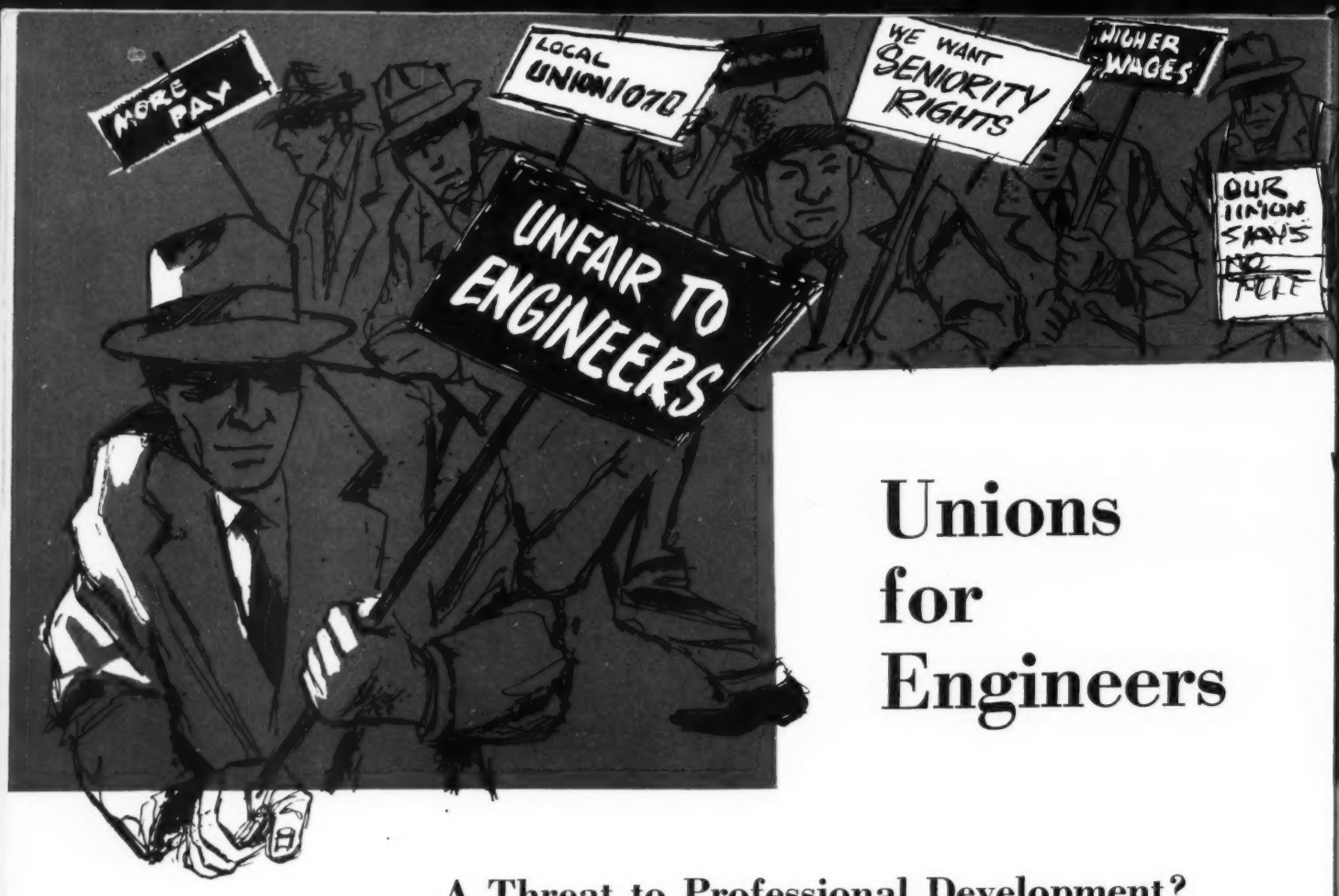


Unions for Engineers

A Threat to Professional Development?

CLIFFORD H. SHUMAKER, Director
The Institute of Management, Southern Methodist University

Clifford H. Shumaker is chairman of the Department of Industrial Engineering and Director of The Institute of Management of Southern Methodist University. He is a registered professional engineer and a graduate in both industrial engineering and mechanical engineering from the University of Kansas. Currently, Shumaker is Vice President and member of the Medals Committee of ASME. In addition, he is the institutional representative, Southwestern Section, of the American Society for Engineering Education.

As director of The Institute, Shumaker often deals with labor and management problems on the technical and engineering level. He has long been interested in the efforts of engineering societies to promote professional development of the engineer.

HAVE YOU CONSIDERED the possibility of picking up your newspaper to find the headlines screaming that a strike of engineers in a particular plant, or even worse, an industry-wide walkout of engineers had occurred? Reading further, you would discover that collective bargaining negotiations between the engineers and management representatives has finally broken down and a long strike is predicted—costly to the company or companies, and posing a serious threat to our defense effort. In other words, a typical report of a typical strike, except that engineers instead of hourly paid workers are the only employees involved.

Ridiculous you say? Not at all! In certain localities of the country, such a thing could happen today. At the present time there is no indication that it is going to occur, but the organization to effect it does exist. This organization is expanding its activities and attempting to extend its influence in other sections of the country to the point where it could enforce its will on a large segment of the business enterprises employing engineers. At the present rate of this expansion, the hypothetical newspaper article might appear sooner than you think.

Professional Societies

Why, when, and how did this all come about? To answer these questions we need to briefly review the history of the engineering profession. For the some 183 years of its existence, there have been spo-

radic attempts to organize those practicing the profession for economic gain—but without success until recently. Instead, we found it more practical to first divide into the general classifications of military and civil engineers. As we grew in numbers and diversity of interest, we branched from the latter into the fields of specialization which we find today. Each individual society has gone its own route, independent of the others, with the consequent lack of coordinated effort to enhance what we like to call the "professional status" of engineers.

During this same period, the medical and legal professions also were growing. Each was careful, however, to retain a single over-all organization to govern the behavior of its members, to act in their behalf when the entire group was affected, and to set standards of performance and admission. Each profession is permitted to establish secondary groups composed of members in particular fields of specialization for such purposes as exchanging information and furthering research, but the principal society or association remains the supreme governing body to which all members are responsible.

A few years ago it became apparent that engineers were following an opposite course. More and more societies were coming into being and what "professional status" may have existed was becoming endangered. By going our separate ways we were getting so far apart that we needed to consider the possibility of uniting in some manner similar to the pattern set by the medical and legal professions.

Unification

The Founder Societies set to work on the problem and soon discovered that there was more involved than merely securing an agreement among the many engineering societies that there should be some sort of unity of organization. To reverse a trend established many years ago and, for all practical purposes, to start over again is something that requires much time, patience, and hard work. However, once the project was under way, many reacted as typical human beings, and patience quickly ran out. As a consequence, the efforts to form a unity organization have been seriously handicapped. This has been a chief factor in the "why" of our question.

Perhaps it would be wise to question whether we are or ever have been regarded as truly "professional" men. We may consider ourselves to be whatever we wish, but lacking that recognition by those outside our fields of practice leaves us without "professional" status. Unfortunately we must admit that the general public and even the employers of engineers have long suffered from doubts as to our right to such a label. Whereas, they deal directly with their physician and their attorney, whom they regard as professional men, the engineer affects their welfare indirectly. Furthermore, since he seldom cultivates their attention by projecting himself into community affairs, he is often looked upon as just another individual who works for a living.

That he must have an expensive college education and technical skill usually acquired in no other way seems to make little difference—and yet the same requisites for practicing medicine and law are generally looked upon as indicative of professional preparation. Therefore, to unite the engineering profession we must first establish it as a true profession, and this contributes still more to the problem facing the societies in their effort.

By now it is generally known that Engineer's Joint Council, composed of representatives of all of the major engineering societies, has been assigned the task of proceeding with unity plans. As evidence that the Council is beginning to accomplish its purpose, witness the action taken in July, 1952. In cooperation with the National Society of Professional Engineers, E. J. C. prevailed upon the Wage Stabilization Board to grant exemption from wage and salary control to all engineers employed in a professional capacity. For the first time, here was national recognition that engineering is a profession. About the same time, Engineer's Joint Council initiated other actions which will further enhance our professional status and lead to eventual unity of purpose and effort—provided those who would impede progress along this line are held in check.

Founding the Union

And now we can answer the "when" of the original question.

The Wage Stabilization Board ruling and the progress of Engineer's Joint Council with its work toward unification of the profession spurred a small group of self-appointed "crusaders for a better life for engineers" into action. Current economic conditions, the shortage of engineers, and the salary scale of employed engineers combined to make the time ripe for such activity.

In late 1952, The Engineers and Scientists of America, an organization whose avowed goal is to organize all engineers for the purpose of improving their economic status through collective bargaining, came into being. In the manner typical of that employed by the usual trade union, E. S. A. has set about creating an exclusive "engineer union" which in one year has assumed sizable proportions. It is for this reason that it is entirely possible for a strike of engineers to occur unless something is done to stop the trend toward organizing to bargain collectively.

Purposes

Let us see further "how" E. S. A. proposes to accomplish its aims.

According to the first president, Joseph Amann, "Engineers and Scientists of America is the only national organization whose members engage in collective bargaining with their employers to speak

for the approximately 400,000 employed, non-supervisory professional engineers and scientists who are so vital to our national defense and to our way of life."

In open meeting at Summit, N. J. on November 19, 1952, the Vice President of E. S. A., John Taft, identified their first activity as follows: "Representation of engineering and scientific employees before government bodies, colleges, political groups, etc., for the purpose of setting things straight with regard to engineers' views on matters of interest to them."

Following his formal address, Mr. Taft stated that "E. S. A. expects to conduct an Industry Evaluation program in which it will study the working conditions, salaries, fringe benefits, etc. of various large firms. The result of the study will be made available to college students as well as to the engineering and scientific profession for their information and guidance." He further revealed that E. S. A. plans to organize student chapters at the major engineering colleges, and he defended this plan by stating that professional societies have student chapters and that his organization is entitled to the same prerogative.

Except that in large part it would merely duplicate information already available from other sources, we can have no quarrel with Mr. Taft's so-called "Industry Evaluation" program—but agreement ceases at this point.

Membership

The total membership in such organizations at this time is in doubt, but it is safe to say that in some areas, notably the West Coast, it is considerable and is still growing. There is ample evidence that there is comparable growth in all sections of the country. E. S. A. claimed some 22,000 members late in 1953, or over 5 percent of the total which the organization is supposed to represent. And all of this has occurred in just one year.

That there is concern about it by the national engineering societies is shown by the questionnaires recently distributed on the subject of engineer unions. It is necessary, therefore, to make a critical examination of what E. S. A. or any similar organization has to offer, its prospect of success, its effect upon professional status and unity of the profession, and its effect upon the welfare of its members.

Assuming that through collective bargaining engineers could force an increase in salaries, the less-than-average engineer in all probability would receive a salary boost—but at the expense of above-average individuals. No union wage structure has ever existed that did not have the effect of leveling off wages, and engineers would be no exception. Hence, what appears to be good for a few comes at the expense of many. In some instances, this might even result in higher average salaries, with the misleading conclusion that averages often produce.

It is a well known fact that the spread in salaries between beginning engineers and those of several years service is insufficient in many instances. This is by way of saying that engineers who have been employed for some time are underpaid by the standards set in hiring recent graduates. In numerous instances, new inexperienced men have been employed at salaries above those paid to men already on the payroll. It is understandable that this should produce dissatisfaction among older engineers and make them susceptible to the appeal of proponents of collective bargaining. The employers of engineers are responsible for this situation and should recognize the danger to which they are exposing themselves by continuing the practice. When demand exceeds supply and prices rise, there should be a comparable increase for engineers already employed. If this were done, one of the chief reasons advanced in favor of collective bargaining would be eliminated.

Individual Initiative

Engineers as a whole create by providing the plans and designs necessary for production. Under a system of collective bargaining, where would the inspiration for new ideas and plans originate? Is there any reason to believe that the stifling of individual initiative that has long existed in trade unions would be absent in an engineer's union? Each individual would receive only the personal recognition accorded him as a member of the group. This would be true just as surely as it is true of the tradesman. Is this the sort of thing which we want to spend four or more years preparing for in college?

What will happen to our present gains in obtaining professional recognition? Years of productive work will be lost and, with them, recognition. Engineering will become just another trade.

But what are the prospects of E. S. A. succeeding in organizing most employed engineers? That depends on you and all of us who prefer to behave and be known as professional men.

Students

One of the statements made by Mr. Taft in his 1952 address was: "Representation of engineering and scientific employees before colleges". Later he stated that student chapters would be formed. This is probably the most dangerous step of all. The development of professional thinking as well as technical knowledge is a part of college training. What would be the attitude of engineering graduates who have been thoroughly indoctrinated with the collective bargaining concept?

Not only are students likely to be subjected to propaganda outside their respective colleges and universities, but also from within through the medium of suggestion by their own instructors. Underpaid college teachers can be quite susceptible to appeals based on promises to improve economic status,

ENGINEER UNIONS HAVE GAINED CONSIDERABLE REPRESENTATION IN SOME INDUSTRIES, PARTICULARLY IN THOSE INDUSTRIES WHICH EMPLOY LARGE NUMBERS OF ENGINEERS TO PERFORM WORK OF A ROUTINE NATURE.

and can exert tremendous influence on the thinking of their students.

A recent occurrence will serve to illustrate the potential danger. At a national society meeting in 1953, a paper was presented by a highly respected instructor affiliated with one of the large universities. The title of the paper and a review seemed to indicate that it would discuss the general economic status of engineers, but when it was delivered it turned out to be an outright endorsement of collective bargaining as the only practical means of improving economic status. Moreover, prepared discussions were delivered by three individuals present, each of whom supported the endorsement.

It is quite obvious that there could have been no prepared discussions without prior knowledge of the author's intention. Not only, therefore, had a college teacher succumbed to the appeal of union proponents, but also he violated professional ethics by delivering an oral address quite different from his manuscript—and with full intent and knowledge that permission to do so would never be granted.

If the author in this case was an obscure and immature teacher it might have little significance. But such is not true. The man has made valuable contributions to engineering literature and he has gained much respect. There can be little doubt as to the philosophy which his students are receiving. If a teacher of this calibre can be converted to the doctrine of collective bargaining, there are thousands of others even more likely to accept it.

Consulting Engineers

Because of their status of self employment, consulting engineers may shrug off the idea that they will be affected by all of this. They will be dragged down to the same level as the rest, however, because the profession as a whole is at stake, and not individual status. There is even some chance that the national societies may tend to minimize the danger. In 1946, a survey similar to the one now being conducted disclosed that less than 5 percent of the engineers questioned favored engineer unions*. Let us suppose that the current survey results in merely holding that figure. Would such a result be cause for alarm? Perhaps the question can be best answered with another. Have we ceased to prepare our national defenses simply because in the same seven years we have not been attacked by a foreign enemy?

Unless steps are taken either to forestall the movement now, or adequately combat it later, there is no question about the eventual success of collective bargaining organizations for engineers. It does not require a mental genius to decide which of those two alternatives is the better.

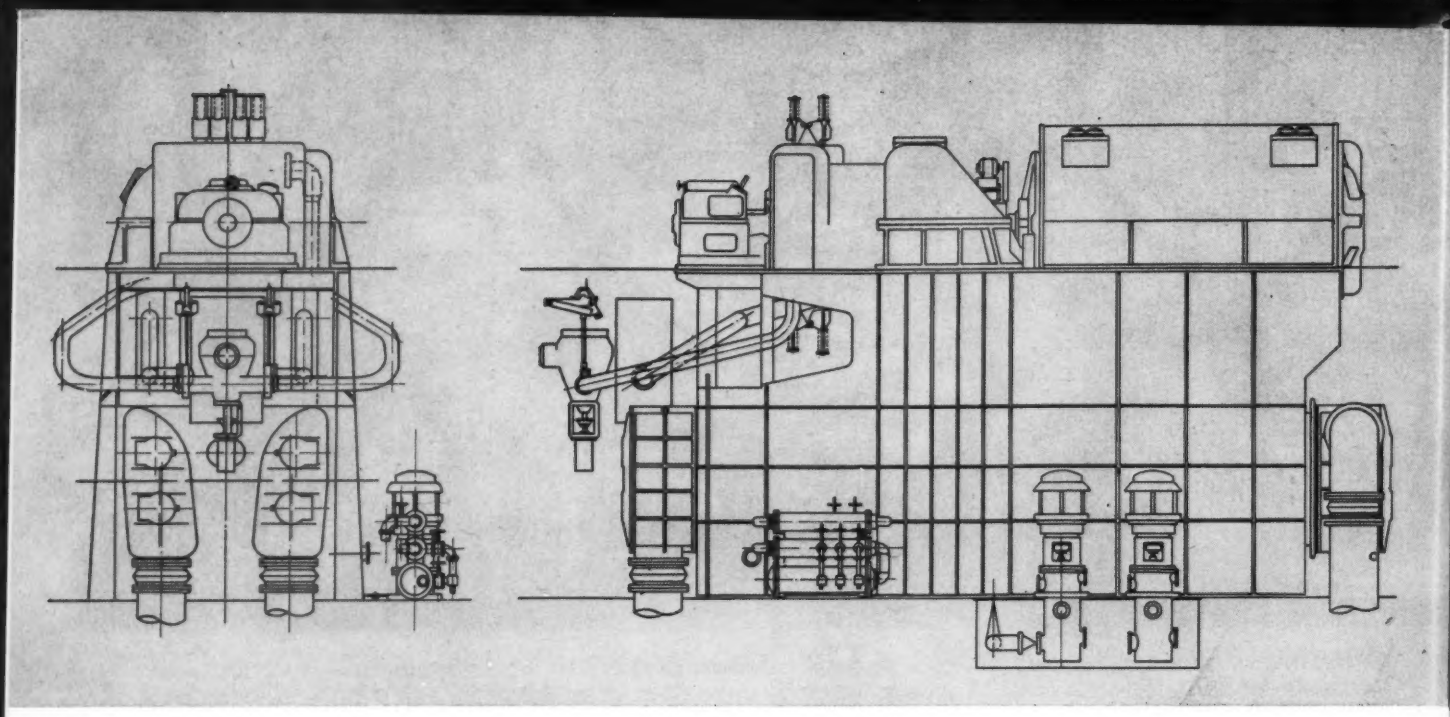
Combating Collective Bargaining

What can be done by way of individual and group action to forestall further advances by proponents of collective bargaining for engineers?

One of the greatest weapons we could acquire would be a full and final recognition of engineering as a profession. What better way than by congressional action? In the Taft-Hartley Act, engineers are permitted freedom of choice with regard to joining trade unions. Why not use this as a springboard for further action to specify engineering as a profession? Through activities by the societies at the national level, with continued and active support by individual members in their respective congressional districts, this could be accomplished. Even now an effort is under way to modify the provision in the

—Continued on page 66

*A report just released by NSPE, "How to Attract and Hold Engineering Talent," states that 34 percent of engineers responding to the questionnaire felt they would be benefited by membership in a collective bargaining organization—against 5 percent in a similar survey in 1946. — ED.



VIEW OF TURBINE END.

SIDE ELEVATION OF A 20,000 KW TURBINE SUPPORTING CONDENSER.

Turbine Supporting Condenser

W. S. MARTYN
Burns and Roe, Inc.

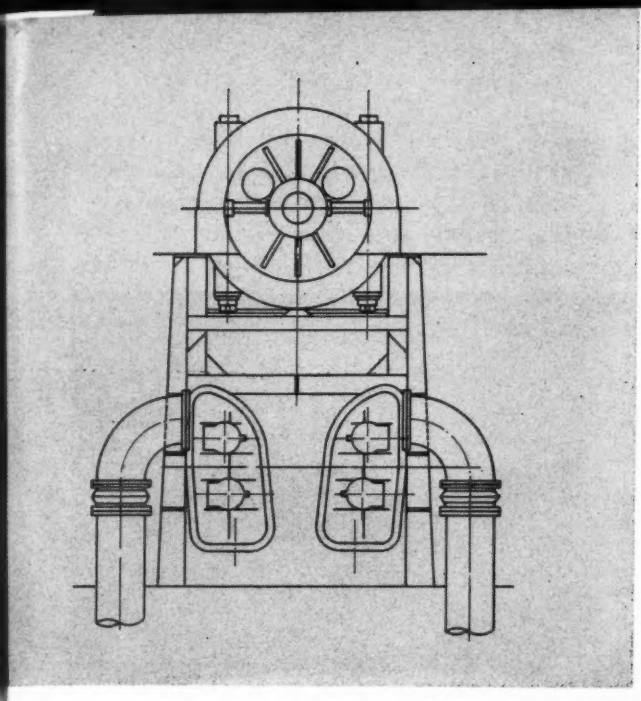
W. S. Martyn was graduated from Syracuse University in 1923, with a degree in Mechanical Engineering. Until 1942, he worked with the power utility at Buffalo, N. Y., which is now a part of the Niagara Mohawk Corp., first as a cadet engineer and later becoming engineer in charge of repairs and replacements at the C. R. Huntly Station. From 1942 to 1944, Mr. Martyn served as a mechanical engineer with Day and Zimmermann, Inc., Philadelphia, and then joined Burns and Roe, Inc., as a project engineer. Now he is assistant chief mechanical engineer in charge of staff group.

J. T. FONG
Burns & Roe, Inc.

J. T. Fong received his degree in Mechanical Engineering from Massachusetts Institute of Technology in 1948. While working as a development engineer with the Griscom-Russell Co., he studied evenings at Columbia University and received his M. S. degree in 1951. Since Jan. 1951 he has been associated with Burns and Roe, Inc. as a mechanical engineer, first with the specialist group and later with the project staff engaged in the over-all coordination of engineering for steam power plants. Currently, he is also on the Columbia Graduate Faculties of Pure Science.

A SURFACE CONDENSER in a steam generating plant appears to be a necessary evil. This is no understatement when consideration is given to the fact that the inefficiency of the best present day steam cycle is caused primarily by the tremendous quantity of low level heat rejected to the condenser. If a person indulges in wishful thinking, he realizes that if he could do away with the condenser, appreciable savings would result. Such procedure would eliminate the investment for all the associated equipment in a circulating water system including the attendant supporting structurals, traveling water screens, and chlorinating facilities in some instances. It also would save the cost of the auxiliary power for pumping the circulating water and the expense of maintaining the equipment. On the other hand, without the condenser, there is no practical way of reducing the back pressure and of recovering the pure condensate for reintroduction into the boiler.

Rationalized thinking, therefore, eventually develops itself along the line of: "What is the best way to live with this necessary evil?" Much may be accomplished toward this end by careful planning in the preliminary stages of a plant layout. One of the newest approaches to achieve good, overall economy is the use of a turbine supporting condenser. The unique contribution of this idea is sheer simplicity of design. It utilizes every structural member of a condenser as a means of support for the turbine-generator. Thus, in addition to the fulfillment of the heat transfer requirements



VIEW OF GENERATOR END.

r Characteristics

in a thermal cycle, such a surface condenser becomes a structural entity in the generating plant.

Design Considerations

When preparing specifications for any condenser, emphasis must be placed on achieving optimum performance. A recent ASME paper[1] presents the relationship between design variables based upon the central idea of maximum plant kilowatt output versus minimum fixed and operating charges for the condenser. In general, a condenser should be selected for its peak performance under normal conditions of operation rather than the usual condition of the station's maximum load at the highest water temperature. This thinking may be revised only when the economic picture is such that a "penalty" results in some territories or systems if the station fails to meet an anticipated maximum demand during the summer months.

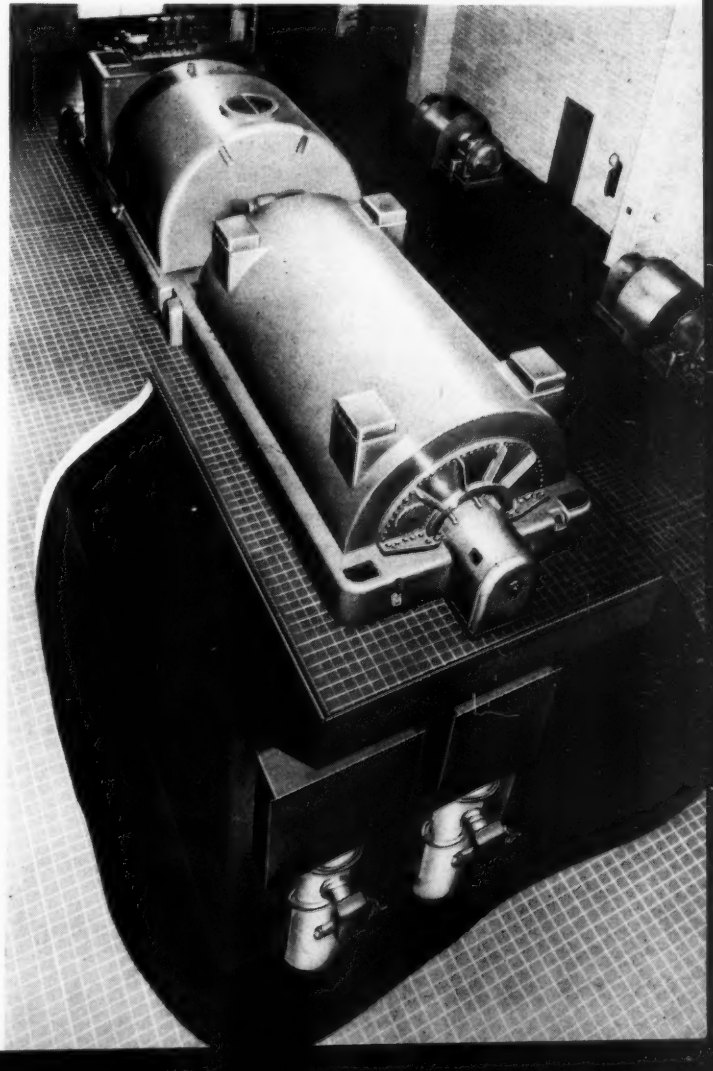
Depending upon the quality of the cooling water available, the material of the selected condenser tubing should dictate the maximum circulating water design velocity. However, the optimum velocity has been found to be far in excess of its present day accepted maximum value, indicating that presently accepted velocity limitations are based primarily on considerations of tube erosion. Design temperature of the inlet circulating water also should be predicated upon the actual or projected loading curve of the station rather than the common rule adopted by some engineers of using the average summer cooling water temperature.

Another controversial design variable is the condenser vacuum, which frequently is taken as the rated turbine back pressure. Thus, the condenser is picked to fit a catalog turbine rating, whereas the proper approach is to determine the economic condenser with its vacuum and then specify the annulus area of the turbine last stage wheels to give a combined turbine-condenser unit built for the optimum operating conditions. Since more condensing surface is required for a high design vacuum than for a low design vacuum, the condenser should be sized to strike a proper economic balance. Of course, tube length and the number of passes are determined by the structural requirements involved and piping arrangement desired.

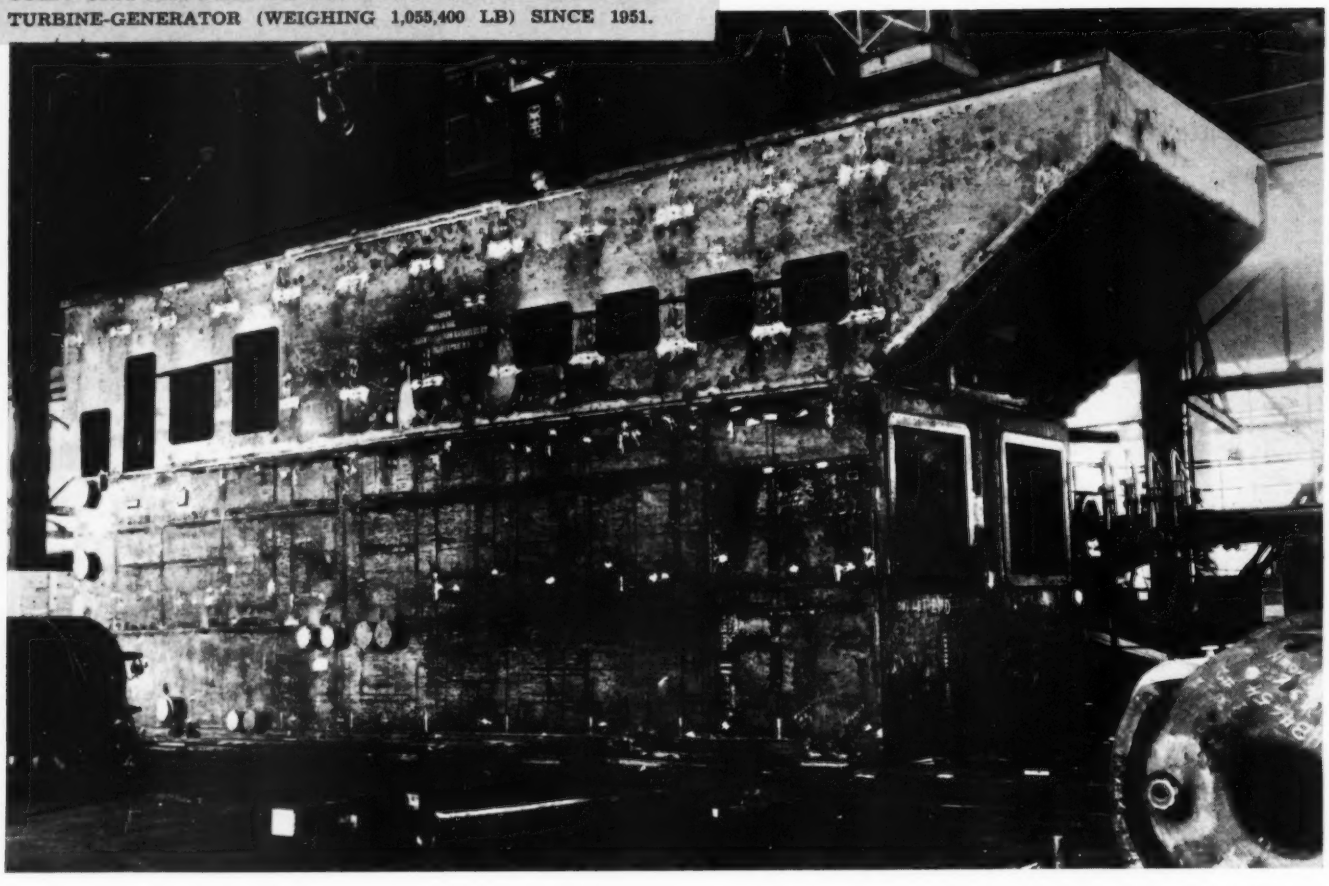
Air Leakage and Tube Fouling

Other considerations in operating and maintaining condensers include air leakage and tube fouling, the principal causes of low coefficient of heat transfer. G. H. Putnam[2] has correlated these factors with condenser performance in terms of percent of maximum heat transfer coefficient with tube fouling and percent of air leakage to the capacity of air removal equipment. Both conditions are ex-

THIS CUT-AWAY VIEW ILLUSTRATES A TYPICAL TURBINE SUPPORTING CONDENSER INSTALLATION.



PHOTOGRAPH TAKEN IN FOSTER WHEELER'S CARTERET SHOP SHOWS THE 46,600 SQ FT, 800,000 LB, SURFACE CONDENSER WHICH WAS BUILT FOR THE DANSKAMMER POINT STATION OF THE CENTRAL HUDSON GAS AND ELECTRIC CORP. UNIT HAS BEEN SUPPORTING A GENERAL ELECTRIC TURBINE-GENERATOR (WEIGHING 1,055,400 LB) SINCE 1951.



tremely important, and usually it is recommended that air leakage should be the first item to check when poor performance is reported. Condenser outage because of fouled tubes prompted the present improved designs using divided water boxes which permit continued operation at a somewhat reduced vacuum while one-half of the tubes are being cleaned.

Turbine Supporting Condensers

Essentially, a turbine supporting condenser consists of a cradle or superstructure, and a condenser shell with its tube nests lowered sufficiently for good steam distribution. Every beam and plate in this type of unit plays an important role in replacing the conventional foundation and supporting the turbine-generator. To illustrate a typical installation, at the Danskammer Point Station of the Central Hudson Gas & Electric Corporation, a 46,600 sq ft surface condenser weighing 800,000 lb supports a 66,000 kw General Electric turbine-generator weighing 1,055,400 lb.

Of necessity, the manufacturers of the condenser and the turbine-generator must work closely with each other and the consulting engineers to coordinate the engineering requirements of their equipment in the over-all design. For example, the turbine-generator manufacturer may specify a spacing of ½ in. between the turbine soleplates and the foundation pad to allow for leveling shims. Meanwhile the condenser manufacturer, unaware of this requirement, may have planned on only a ⅛ in. spacing since less machining is involved. The consultant must resolve such differences so the proper elevation is obtained at the project site.

Since structural considerations are the critical ones, units of completely welded construction are the most desirable. Of course, the size of the condenser, the capacity of the manufacturer's shop, or the shipping problem may necessitate fabricating the unit in several sections, and this will be one of the determining factors in awarding this type of contract. The least number of sections generally will be favored for ease of handling and field assembly and for over-all rigidity.

Vibration

One consideration that merits attention is the capacity of the condenser to absorb any form of vibration developed by the turbine-generator. The

physical dimensions of all components including individual plates or beams should be designed so that no resonant vibration will be induced by the 60-cycle frequency. In this respect, favorable testimonial to the supporting design is evident in reports on the Danskammer unit which has been on the line since 1951. Typical vibration measurements taken at the four turbine-generator bearings of this machine indicate a constant maximum amplitude of 0.25 mils, or only ¼ of the value which turbine-generator manufacturers have been required to give in a contractual guarantee covering maximum vibration of any stationary part.

While one of the criteria of the soundness of an ideal turbine-generator support is its damping capability against any form of vibration, if difficulties did develop, it is possible to correct such conditions. Should any induced vibration occur at any place within the condenser, the physical length of the member concerned may be easily altered by changing the location of its supports, and thus "tune out" its resonant frequency.

Currently, the largest turbine supporting condenser in the country — an 80,000 sq ft, Westinghouse, radial flow condenser supporting a 100,000/125,000 kw General Electric turbine-generator weighing 1,252,130 lb — is being designed under the supervision of Burns and Roe, Inc. This unit will be installed at the Jersey Central Power & Light Company's Raritan River Plant as part of its 1954 extension program.

Advantages of Supporting Design

The design characteristics of a turbine supporting condenser offer many advantages besides eliminating the necessity for a separate foundation. Less head room is required between the basement floor and the operating floor. This is an extremely desirable feature, for in poor soil conditions the structural savings in excavation and sheet piling are considerable. When extending old plants, the same turbine room floor elevation frequently can be maintained with immeasurable conveniences for the operators.

Often the width of a conventional concrete foundation exceeds that of a turbine supporting condenser, while the spaces left for auxiliary equipment remain unchanged. In some instances this permits the use of the same turbine room crane in an extension, due to the reduced width of the new turbine room. It further results in a pulling space of the condenser tubes approximately equal to that of the generator rotor — and both in the same direction.

The Danskammer plant offers ample evidence of the reduced dimensional requirements when using turbine supporting condensers. At this plant, a saving of approximately 14.5 percent in the building height[3] was achieved, and the total volume is only 22.5 cu ft per kw. A conventional plant with structural steel foundations for the turbine-generator and having similar general arrangement of all other major equipment requires 26.5 cu ft per kw. Such reductions in the distance between the operating floor and the basement floor and the over-all plant volume produce savings in both material and labor for piping, conduits, and cable tray runs.

Lowering of the tube nests to facilitate good steam distribution also permits the enclosing of low pressure bleed heaters in the neck of the condenser. For example, two low pressure direct contact stage heaters are being enclosed in the condenser now being constructed for the Raritan River Plant. Furthermore, turbine supporting condensers afford the possibility of designing and routing of the bleed steam piping through steel plates in a much simpler and more economical way than through massive concrete supports.

Since each part of the condenser proper, equidistant from the operating floor, is under the same condenser vacuum temperature while all parts above the condenser are subjected to room temperature, this design prevents any unequal expansion. It also permits maximum factory fabrication of parts and piping which minimizes field assembling and erection time. Again, the Danskammer unit provides an excellent example. Only two weeks were required to ship from the Foster Wheeler Corporation, Carteret Shop and assemble the condenser ready for the erection of the turbine-generator.

Conclusions

Faced with ever increasing initial capital investment, fuel cost, and operating and maintenance expense, the utility companies have been seeking every means for economically generating electricity. In this field of engineering, progress in the art has been slow but steady and sure. Power plants have been standardized[4] to simplify engineering, facilitate construction, and reduce over-all cost. Steam conditions at the turbine throttle have been steadily going up to save fuel cost. Centralized control and unit turbine and boiler layout were all milestones on the road of achievement in power plant design. With careful engineering and coordination of design, the turbine supporting condenser provides another answer to the challenge of high costs and another significant step toward the common goal of economy.

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PERSONAL INTERVIEWS REQUIRE CONSIDERABLE TIME. APPLICANTS SHOULD BE THOROUGHLY SCREENED TO ELIMINATE THE UNQUALIFIED BEFORE INTERVIEWS ARE ARRANGED.

How to Hire (and Hold) Engineers

RICHARD S. MAC QUOWN, Director
Tomsett Associates

Richard S. MacQuown graduated from Carnegie Institute of Technology in 1941 with a BS degree in Management Engineering. Prior to joining Tomsett Associates, he spent four years as an industrial engineer at the Duquesne Works of U. S. Steel Co., and three years as plant manager for Atlas-Ansonia Co. in New Haven, Connecticut. He is a member of the American Society of Mechanical Engineers, and has recently been elected president of the Pennsylvania Association of Personnel Services.

THERE ARE FEW MEN in managerial positions who have not either experienced or witnessed serious mistakes in the handling of human relations and in the application of fundamental techniques of personnel recruitment and administration. The engineer, as an employer, has not been exempt from such errors.

When engineers become employers, either as the result of successful consulting practice or of promotion to executive responsibility within a company,

they suddenly come face to face with the necessity for effective employment practices. No employer, no matter how specialized his training in a particular field, cares to make the costly mistakes of an amateur in the handling of men. The engineer who regards this as a problem to be studied finds that his personnel relations score can be greatly improved.

Employees are definitely interested in the conduct of their company, and they are likely to exhibit considerable regard for their status and progress. In active business periods, they have a choice as to where and for whom they will work. Just when they are needed most to fill the increasing commitments of a booming company, men are at a premium. During periods of lessened business activity, more men are available, and the problem becomes principally one of selection. Although this is the employer's opportunity to up-grade his organization, he is generally too concerned with sales and monetary matters to take advantage of the situation.

During recent years of expanding technical activity, the recruitment of capable men has become a major management problem. A preliminary requirement for successful recruitment is that the employer himself develop a clear idea of what he wants in the new employee. This should exist in the form of a well-organized, written job description.

Job Description

The job description isolates and states the specifications for a qualified candidate. In resume form it highlights length and type of experience, education, personal characteristics, and any other basic requirements a candidate must meet to perform the duties of the position he is being asked to fill.

In writing job descriptions, highly detailed specifications listing every known desirable human characteristic can be just as unworkable as vague verbal descriptions. Recognize the fact that for most jobs it will be necessary to employ a somewhat ordinary human being. Nothing should be included in the job description which is not pertinent.

If specifications are realistic, the job description will be a remarkably accurate and workable tool. Unrealistic descriptions generally result in much loss of time and money in locating and rejecting men who could do the work, but do not meet the specifications as written. Furthermore, it should be recognized that payment for ability and experience which are not actually needed is waste. On the other hand, persons working in positions which do not require full use of their abilities tend to be unhappy.

The form shown in Figure 1 provides the basic data needed to determine if a candidate qualifies for the job at hand and if a personal interview is warranted.

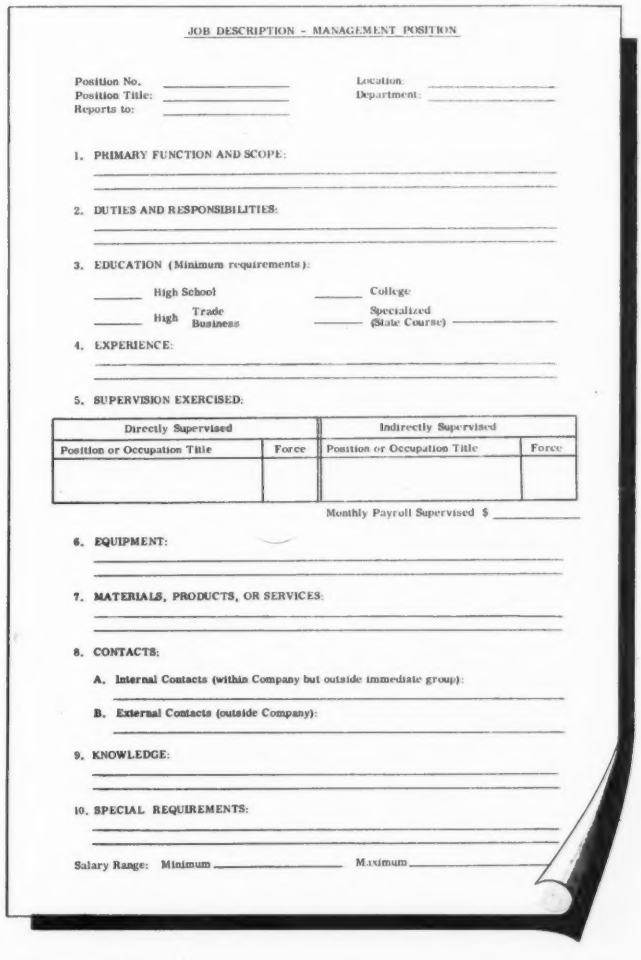
At this point, the company management may simply turn the job description over to a competent private management personnel service and go about its business until, in due course, interviews may be arranged with one or several qualified candidates.

Modern, specialized technical and executive personnel services can provide excellent results at a very low cost. The rapid growth of this relatively new management tool has brought substantial relief to hard-pressed managers of business and industry. However, this does not mean that other methods are not still available and much used.

Recruitment

Possibly the procedure used the most by employers is to place advertisements in newspapers, trade papers, and other publications likely to be read by qualified applicants. Often a large and expensive ad will produce tremendous response, but frequently from hopelessly inadequate persons who read themselves into even the most carefully worded specifications. The right man might be found somewhere in that mass of letters provided the employer can afford the time and is willing and able to consider, interview, and investigate enough of the replies to give himself the mathematical chance for success.

One of the largest corporations to advertise heavily for engineers has figured that its out-of-pocket



JOB DESCRIPTION - MANAGEMENT POSITION

Position No. _____ Location: _____
Position Title: _____ Department: _____
Reports to: _____

1. PRIMARY FUNCTION AND SCOPE:

2. DUTIES AND RESPONSIBILITIES:

3. EDUCATION (Minimum requirements):

_____ High School _____ College
_____ High Trade Business _____ Specialized (State Course) _____

4. EXPERIENCE:

5. SUPERVISION EXERCISED:

Directly Supervised		Indirectly Supervised	
Position or Occupation Title	Force	Position or Occupation Title	Force

Monthly Payroll Supervised $ _____

6. EQUIPMENT:

7. MATERIALS, PRODUCTS, OR SERVICES:

8. CONTACTS:

A. Internal Contacts (within Company but outside immediate group):

B. External Contacts (outside Company):

9. KNOWLEDGE:

10. SPECIAL REQUIREMENTS:

Salary Range: Minimum _____ Maximum _____

FIG. 1—TYPICAL JOB DESCRIPTION FORM PROVIDING DATA TO DETERMINE APPLICANT'S QUALIFICATIONS.

recruiting costs by this method ranged from $500 for each junior hired to over $6000 for each key technical man or supervisor placed on the payroll. As a matter of comparison, the fees charged by one technical and management personnel service are shown in Table 1. These fees include advertising, screening, investigation, know-how, and contact with all factors in the field.

Blind ads are sometimes used because the employer does not wish his employment plans or problems to become known. This limits replies, since qualified men do not want to endanger their current employment relationship. On the other hand, frequent ads appearing with a company name develop the impression that turnover must be heavy and that the company would be a poor place to work.

In their search for applicants, some companies like to "spread the word" among trade associations, business acquaintances, employees, salesmen, and other contacts. Such procedures are generally inefficient, since well-meaning, but indiscriminate, friendly referrals carry the obligation of time-consuming interviews and consideration out of all proportion to the merit of most of the applicants.

Screening Candidates

As applicants are obtained, screening is necessary to determine the best applicant for the position. For routine jobs the first step in screening is usually a preliminary interview, while for key positions it is generally a written resume of qualifications.

A well-organized resume enables the reviewer to determine the actual degree of fit between the experience, education, and general background of an applicant and the duties involved in the opening. At this stage the element of distraction by an applicant's personality is to be avoided.

The employer's next logical move is to request a personal interview. This may include a technical discussion or informal verbal test, but fundamentally it presents an opportunity to measure appearance, personality, and attitude. Being human, the impact of an applicant's personality tends to have a strong influence on an employer.

But personality, within limits, may not be of prime importance, so he should keep the job specifications clearly in mind during the interview.

Some engineering employers use ability or psychological tests, particularly for trainees or young men hired primarily on potential. When this procedure is followed it is important that expert advice be obtained in order to avoid many very real pitfalls in connection with both the testing and interpretation of results.

Investigation and check of references are the final screening steps. When it appears that a position will be offered and accepted, this must be considered contingent upon the satisfactory clearance of a normal investigation. An employer can make the character check himself by contacting the references submitted by the applicant. It must be recognized, however, that few applicants will offer character references that will not be favorable. Usually, a little applied ingenuity will produce accurate facts. A number of commercial firms specialize in making investigations, and their services can be obtained for a moderate cost.

It is more difficult to measure proven ability. The attitudes and opinions of the person serving as reference will have a marked influence on the information obtained from former employers and other professional references. Inasmuch as the references are frequently unknown to the prospective employer, the employer has only a vague basis for evaluating the information he obtains. Nevertheless, if the indications of resume, interview, test, character investigation, and check on past performance are fairly consistent, results should be quite conclusive.

Personnel Service

The services of a technical and management personnel service relieve the employer of the burden of locating and screening applicants, leaving him free to interview a small, well selected group of qualified men. When the executive time, effort, and cost required for a company to conduct its own recruitment program is considered, many profit-minded employers conclude that professional personnel service is worth the price.

The resourceful personnel service establishes wide contacts, maintains offices in locations convenient to applicants, and assumes the cost of advertising itself locally and nationally as a central clearing house for both employers and employees. It also provides college-trained interviewers and specialists experienced in business and industry. In addition, it gives counselling service to job applicants and to its employer clients.

However, if an employer's recruitment program is to bear fruit, something more is needed. Regardless of how effective a personnel service or any other method may be in producing the candidate, the employer must be able to attract and hold the man.

Attracting Good Candidates

When business is active and a good employee can produce a worthwhile profit, the employer often finds himself in competition with other employers interested in securing the services of the selected candidate. In such instances, the employer must sell the applicant on the fact that joining his organization is the best move he could make.

This selling process should start with the first contact and, throughout the recruiting procedure, should reflect the type of organization with which competent men want to associate themselves. Prompt, courteous, and business-like negotiations may be crucial. The job itself should be clearly de-

fined, and an accurate picture of the limits of responsibility and authority should be drawn for the benefit of the applicant as well as the employer.

If the duties merit a title, it should be conferred. Recognized status in an organization is one of the really important job attractions, the most important in many instances.

The company representative who does the interviewing should hold sufficient title and authority to satisfy the applicant that a worthwhile interview is being conducted. Obviously, the candidate for a $15,000 executive opening should not be interviewed by a $4000 personnel assistant. The company representative should be in a position to influence the final decision, and he should have enough company background to answer questions intelligently.

Money, another important consideration, must be competitive. The desire to play it safe by starting an employee at a low salary with subsequent raises after he has proved himself is not realistic in a competitive market nor will it secure the experienced man who has already proved himself elsewhere. The promise of a bonus is not a substitute for a sound and fair commitment. Furthermore, if a good man is to be held in the organization, his income must continue to reflect his true value.

In most instances there must be some assurance of job security. If it is impossible to provide this, this fact should be understood. Few competent men want to change to an unstable, inconsistent, or unsuccessful firm where their position might become untenable.

The future also is important, particularly to younger men. A planned system of progress, salary review, and promotion should be defined. Most capable men will realize, of course, that definite promises cannot be made since the future hinges on their individual performance and on the fortunes of the organization.

Least important, but also worthwhile, are such factors as working conditions, fringe benefits, location, expense policies, and the like.

Fundamentally, an employer must decide if he wants to pay the price of honesty, unselfishness, hard work, imagination, competence, and other characteristics that distinguish employers who are able to hold good personnel. The competent and honest employer attracts the competent and honest employee.

Holding Employees

Personal interviews with thousands of technical, executive, and professional men have provided case histories which plainly show why some companies are able to hold their men and why some are not. The companies which get the best results are those which recognize and ably meet the facts of life applicable to this phase of their operating efficiency.

Each man should be made to feel that he has stature in the organization, that he has opportunity for progress, that merit will be recognized, that management is aware of his contribution, that he has reasonable job security, and that the company itself has a future. Salary scales and other compensation should be in keeping with area levels and general professional standards, and increases in the value of services given should be voluntarily and promptly recognized by increases in compensation. In addition, working conditions and supervisory procedures should be satisfactory.

TABLE 1 — EMPLOYMENT FEES FOR MANAGEMENT AND TECHNICAL SERVICE

Annual Starting Salary	*Recruiting Fee % of Annual Salary Rate**
Up to $3000	5%
$3000 to $6300	6%
$6300 to $8100	7%
$8100 to $9300	8%
$9300 to $10,500	9%
Over $10,500	10%

* Rates shown in this table are charged by the author's firm, and have been established on a definite cost basis. There is no charge for service unless the position is offered to the applicant by the employer and accepted.

Working Conditions

Equally important to both employer and employee is the proper utilization of the men employed. Work should be available, and it should be properly scheduled and assigned to the right individuals. The proper balance in forces should exist so that employees are able and willing to do the assigned tasks. Lower paid draftsmen and technicians should be assigned detail work, leaving highly trained engineers and others free to do the jobs requiring ingenuity and imagination.

The engineering employer and his client should make clear-cut operational decisions. The tendency of some management to put off the making of difficult decisions wastes time and creates confusion. In effect, it shifts the management prerogative by default to the employee, who should not be expected to assume basic responsibility and who is not in a position to have the over-all perspective to render the best decision.

Ultimately, every problem in attracting, holding, and utilizing personnel must be faced by a successful management. The solution to each problem will depend upon ability to objectively recognize mistakes and correct them.

When an employer realizes that stable employment and low turnover in personnel are possible, and when he decides he wants it enough to do what is necessary to obtain it, the first and most important step has been taken.

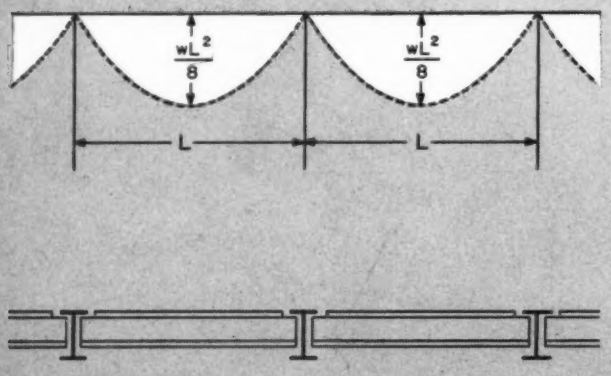
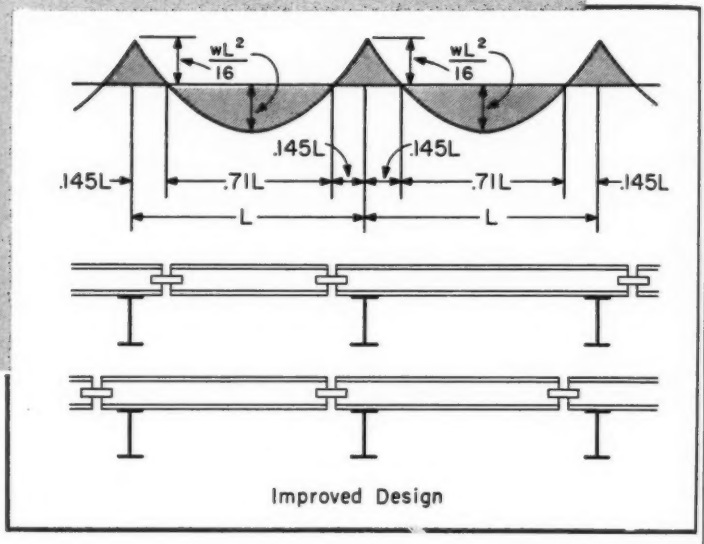


FIG. 1—BENDING MOMENT FOR HINGED PURLINS, SHOWN BELOW, IS COMPARED WITH THAT FOR CONVENTIONAL METHOD OF FRAMING INTO BEAMS, AS SHOWN AT LEFT.



Economy in Structural Design

PAUL ROGERS, Rogers & Snitoff, Inc.

Paul Rogers, a registered engineer and a partner in the consulting firm of Rogers & Snitoff, Inc., is this year's recipient of the J. James R. Croes Medal awarded by the American Society of Civil Engineers. Born in Hungary, he graduated from the Ecole du Genie Civil, Paris, in 1934. He came to the United States in 1939, attended graduate school at Illinois Institute of Technology, and became a naturalized citizen of the United States in the year 1945.

Mr. Rogers has been associated with Sargent & Lundy, Ralph H. Burke, Roberts & Schaeffer Co., A. J. Boynton & Co., and Pioneer Service & Engr. Corp. He has authored numerous papers, and recently published a book, "Tables & Formulas for Fixed End Moments". He also serves as a part-time lecturer at Illinois Institute of Technology.

IMPORTANT ADVANCES have been made in the field of structural analysis during the last few decades. Numerical systems enable designers to apply continuity whenever feasible; improved welding techniques allow new types of connections; and new types of deformed bars have improved reinforced concrete construction.

It is often possible, by the use of logical deductions, to obtain even greater economies than those secured by proper analysis alone. The methods described in this article can be used to bring about considerable savings without diminishing the factor of safety of the structure. Some of the techniques are new, while others have been used successfully but are often neglected.

Although structures serving any purpose should be economically designed, the methods described are intended specifically for use in the structural design of power plants. Because of their complexity, this type of plant offers a challenge for improved structural analysis and design.

Because of light loading on roofs and reasonable

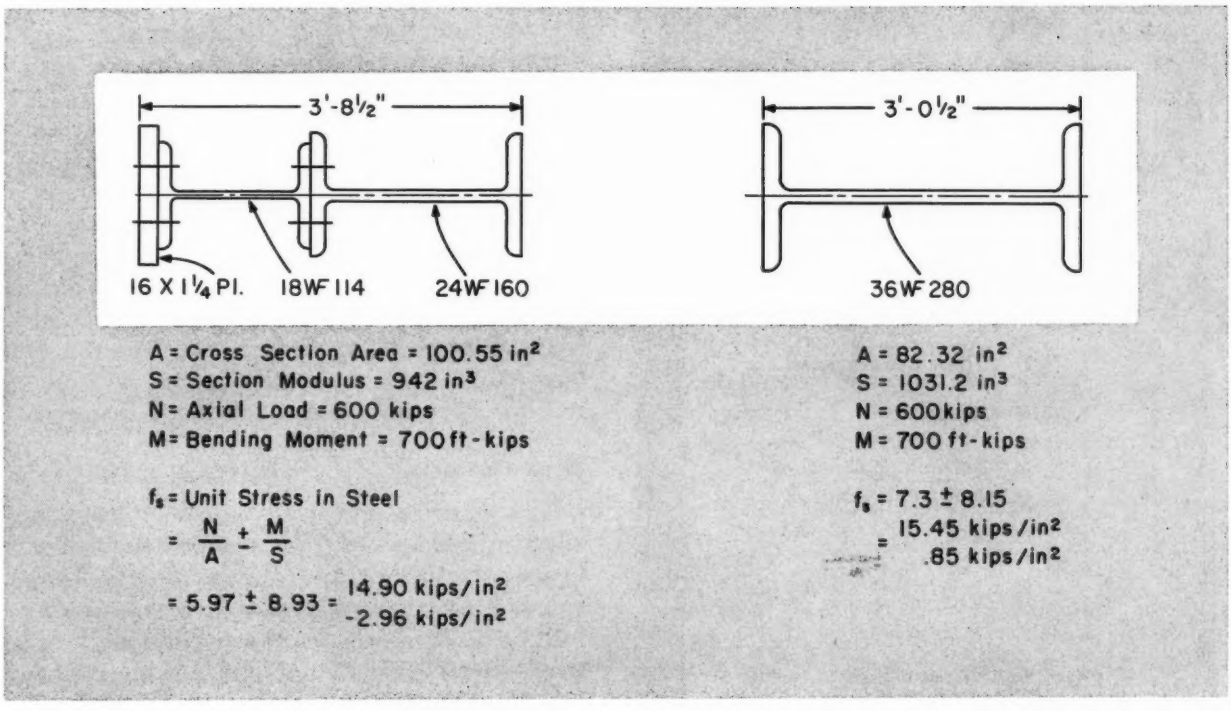

3'-8½"
16 X 1¼ Pl.
18WF 114
24WF 160
3'-0½"
36WF 280
A = Cross Section Area = 100.55 in²
S = Section Modulus = 942 in³
N = Axial Load = 600 kips
M = Bending Moment = 700 ft-kips
f_s = Unit Stress in Steel
= N/A ± M/S
= 5.97 ± 8.93 = 14.90 kips/in²
-2.96 kips/in²
A = 82.32 in²
S = 1031.2 in³
N = 600 kips
M = 700 ft-kips
f_s = 7.3 ± 8.15
= 15.45 kips/in²
.85 kips/in²

FIG. 2 — SAVINGS IN STEEL AND REDUCED COLUMN DEPTH MADE POSSIBLE BY USING A SINGLE MEMBER FOR CRANE COLUMNS CAN BE SEEN BY COMPARING WITH AN EQUIVALENT DOUBLE MEMBER DESIGN.

uniformity of the loads, roof construction usually consists of purlins carrying lightweight, possibly precast, concrete slabs. As a rule, such purlins frame into beams or girders.

It can be proven that savings as high as 38 percent can be attained by employing hinged purlins resting on the top of the girders instead of the conventional framing into the webs of the supporting beams.

As an example, for a span of 20′-0″ and purlin spacing of 7′-9¾″, the conventional design requires 10 WF 21 beams with a deflection of 0.66 in. The improved designs, on the other hand, allow the use of 8 B 18 beams with a maximum deflection of 0.69 in. In addition, no coping is necessary with this system.

Crane Columns

Some designers prefer using double members for the stepped-up crane columns, thus separating the crane and roof loads. Obviously such a separation cannot take place because double members, thoroughly riveted or welded together, will always act together. Inasmuch as such columns have to resist considerable bending moments due to crane thrust,

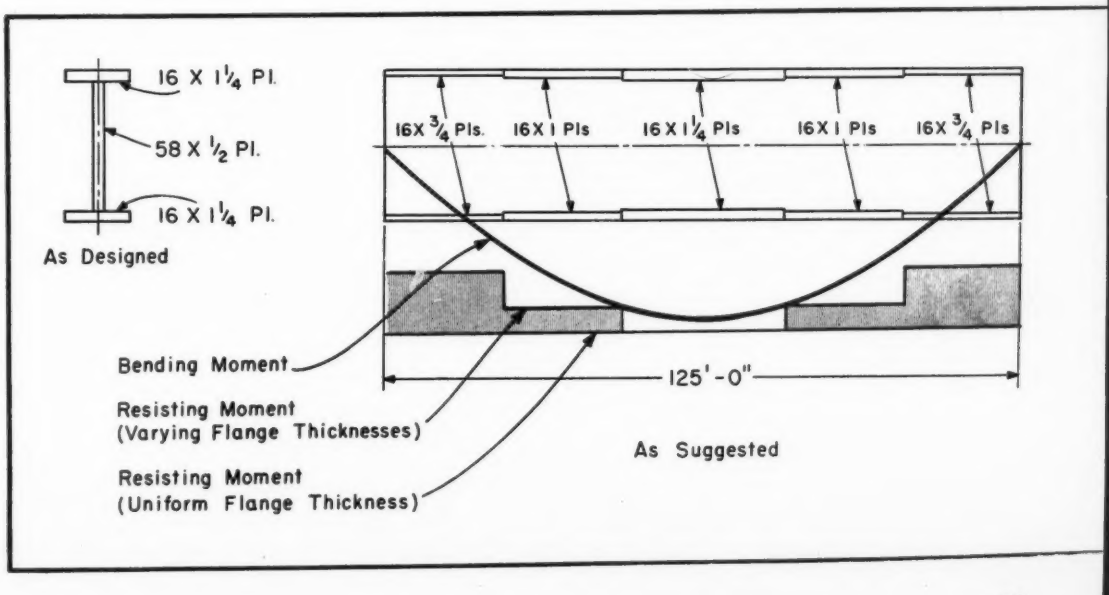


FIG. 3—COMPARISON OF THE RESISTING MOMENT FOR THE GIRDER WITH UNIFORM SECTION, SHOWN AT LEFT, AND THAT OF A GIRDER BUILT WITH REDUCED FLANGE THICKNESSES.

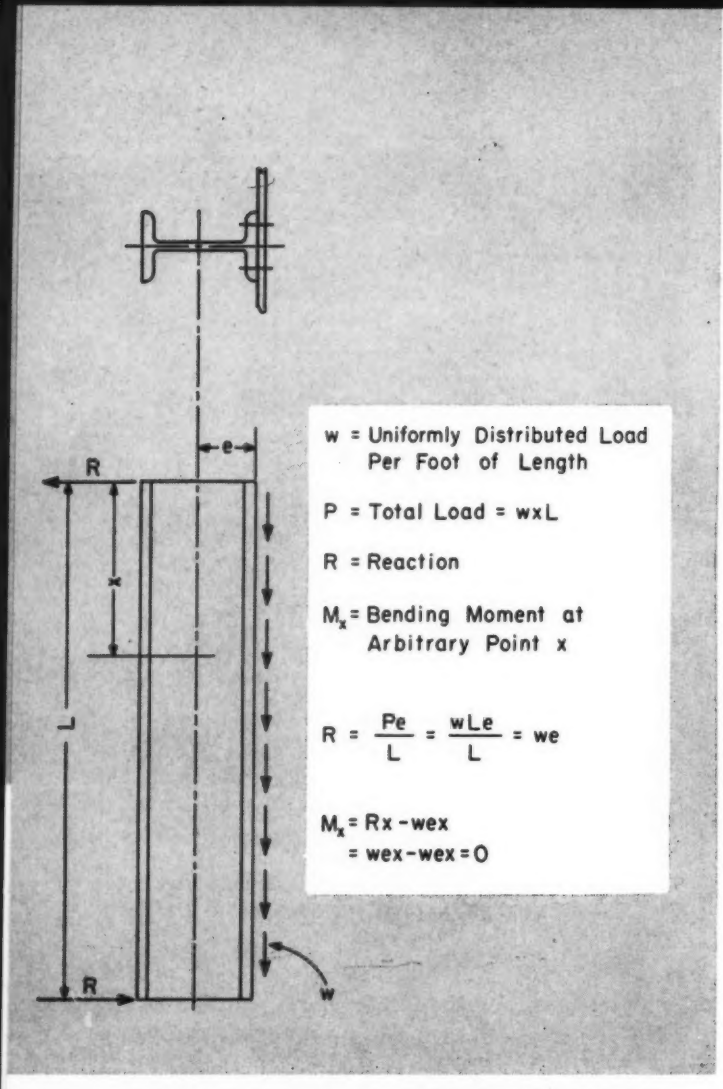


FIG. 4 — DIAGRAM SHOWS FORCES RESULTING FROM CONNECTING BUNKER WALLS TO THE COLUMN FACES.

wind, and eccentricity, such double member columns cannot be utilized to their fullest capacity because the material near the neutral axis does not contribute to the flexural resistance of the column. The suggested single member column not only saves 18.1 percent of steel, but it also provides a reduced depth and eliminates four rows of rivets or welds, thus permitting a total saving of 23 percent.

The upper portion of the column, supporting roof load only, can be reduced to a smaller sized beam. If the crane girder is placed at or near the upper third of the total height, the crane load eccentricity will produce zero fixed end moment at the upper end.

Girders

The indiscriminate use of column centerlines for spans should be discouraged. For a restrained beam, the point of inflection moves considerably inward within the span. For a truly simply supported beam, the point of inflection coincides with the actual support. Consequently, in the case of a beam framing into the flange of a column, the true span can under no circumstances be more than the clear distance between the flanges of two columns.

Inversely, the use of column centerlines for spans may be seriously unsafe for shear when the beams are unsymmetrically loaded, such as boiler-drum supporting girders. Through the use of clear spans, savings up to 10 percent are possible.

The prevailing practice of designing long span girders for maximum moment, and retaining the same section throughout the full length also is unjustifiable. A recent turbine room installation where 125-foot span girders with uniform section were employed is shown at the left of Figure 3, as contrasted to the same girder had it been fabricated with the reduced flange thicknesses shown. The reduction of flange thicknesses suggested in this example would result in about a 13 percent saving in material.

Wind Connections

Both analysis and experiments indicate that the customary heavy split-Tee wind connections virtually prevent angle-changes at the supports. Thus if the columns are rigid, the beams will approach nearly full fixity. The design of such girders for full positive moment is wholly unjustified and wasteful. Even if reasonable conservatism guides the designers, the selection of beams ought to be based on reduced bending moments.

On the other hand, the wind connections proper must be designed for the sum of the wind and restraining moments. Such precaution is more than compensated for by the saving of steel in the beams, which may amount to as much as 26 percent.

Parts of a structure which are of permanent nature and are not expected to undergo alterations could be designed as rigid frames. A typical example is the turbine room framing for which the rigid type of construction not only would materialize a saving of about 18 percent but, through reduced deformations, would create a far more favorable structure with pleasingly proportionate sizes for the members.

Coal Bunker Layout

Some designers prefer narrower coal bunkers than the corresponding column bays. Such a layout may permit the installation of galleries between the bunker wall and the column rows. It should be realized, however, that such a layout is uneconomical. If the bunker walls frame directly into the columns, all longitudinal and cross-girders are eliminated, permitting a saving of about 22 percent.

The bunker walls should connect to the face of the columns. This brings about considerable savings in detailing, fabricating, and field work. Contrary to common belief, Figure 4 shows that a continually applied eccentric load does not create bending moments in the columns.

Vibrations

In order to avoid disturbing vibrations, the turbine supports must have natural frequencies higher than the revolutions of the turbo-generator. Fre-

quencies increase with the square root of the moment of inertia and decrease with the square root of the weight. The ideal cross-section for these conditions is the "I" section, as against the customary rectangular cross-section. Casting concrete "I" sections is not difficult and a further advantage is gained because such girders can be weighted in case of undesirable vibrations. Casting reinforced concrete "I" sections can save up to 14 percent of material and may improve functioning of the unit.

Vibrations can be induced by so many factors that no mathematical analysis can give guarantee that vibrations will not occur. Objectionable vibrations develop when any of the natural frequencies coincide with the revolutions of the supported machinery.

Increasing Natural Frequencies

Frequencies increase with the reciprocal of the square root of the elastic deformation of the member. Several methods can be economically employed to eliminate the resonant vibrations in the supports of rotating machinery, should they occur.

Open grooves, preferably following a parabolic line, can be provided for on both sides of girder spans. Then, if disturbing vibrations do occur, cables or high tensile rods can be inserted in the grooves and proper anchorage can be furnished.

By tightening the cables, both flexural and shear deformations will be reduced with subsequent increase of the natural frequency of the girder. Such tightening may be applied experimentally, without the use of expensive gages and other instruments, until the vibration has subsided.

The exposed grooves permit close inspection of the cables while tightening, they permit the insertion of friction-reducing implements, and they facilitate the application of a protective covering after the cables have been tightened.

When steel girders are involved, welded lugs may be used as the cable guides.

Under ordinary circumstances, the cables are not needed. If vibrations develop during operation of the machinery, however, the cables can be inserted and tightened at very little cost and in the shortest possible time. Additional tightening can be applied anytime during the economic life of the plant to compensate for relaxation due to plastic flow and creep.

Conclusions

The improved designs discussed in this article can be used to gain considerable savings without the reduction of safety factors. For large projects, such as power stations, the savings may amount to several hundred thousands of dollars.

As our country enters a new era with special emphasis on economic considerations, it is up to engineers to contribute to the national economy through the design of safe and economical structures.

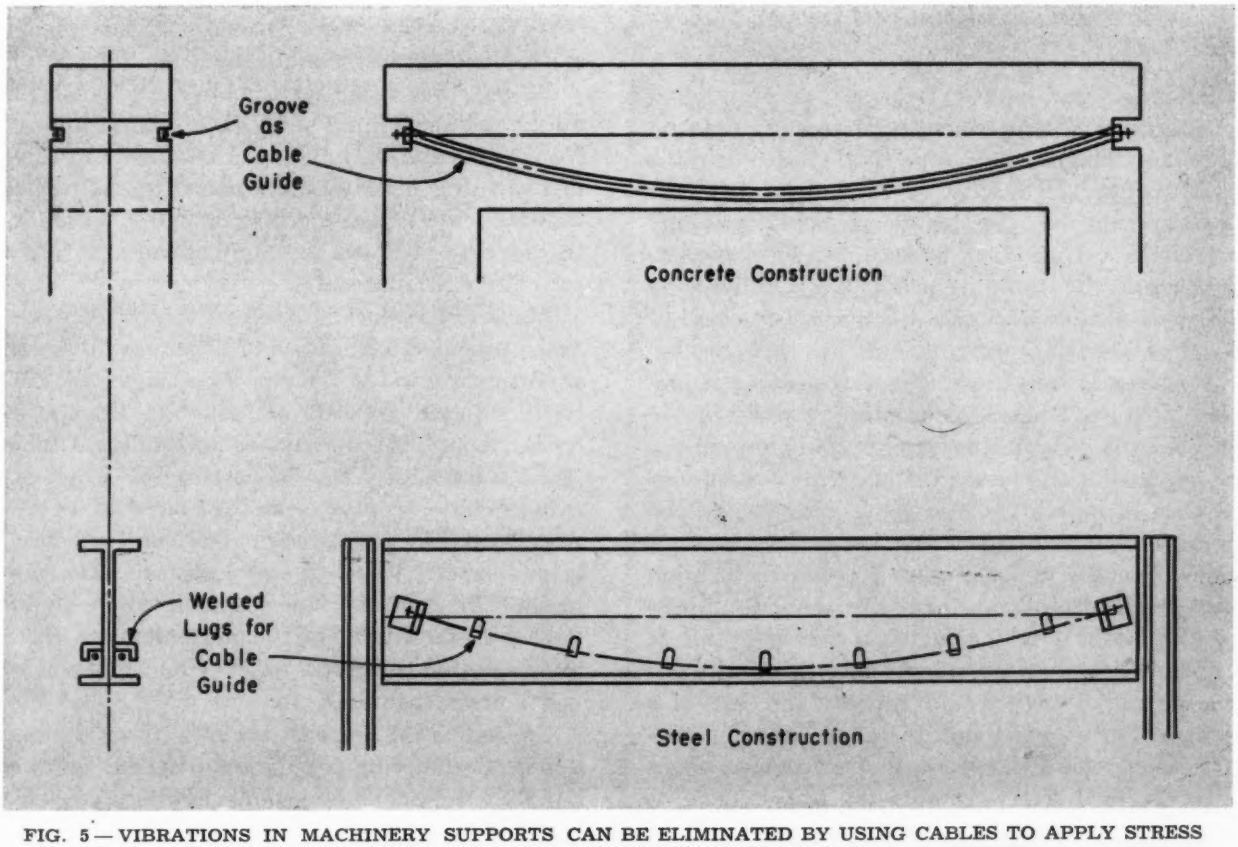
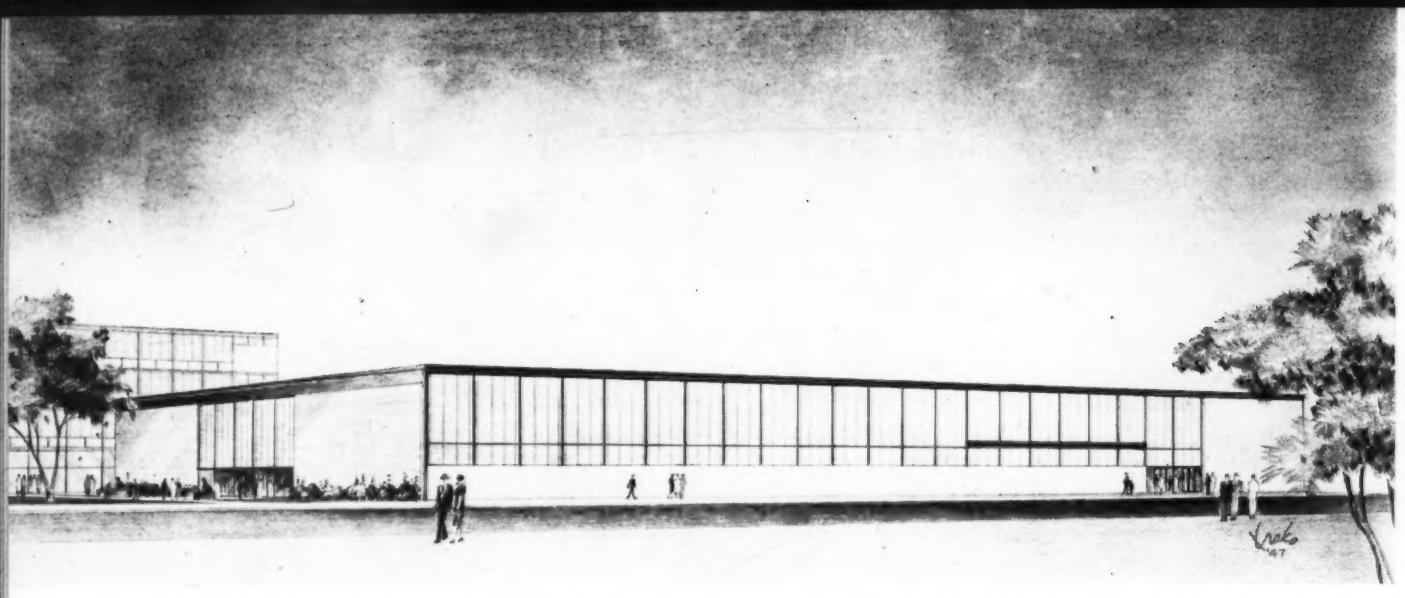


FIG. 5 — VIBRATIONS IN MACHINERY SUPPORTS CAN BE ELIMINATED BY USING CABLES TO APPLY STRESS TO THE BEAMS. WHERE VIBRATIONS MAY OCCUR, CABLE GUIDES CAN BE PROVIDED IN ADVANCE.



ARCHITECTS SKETCH OF THE TYPE OF BUILDING PROPOSED FOR SOCIETY HEADQUARTERS ON THE ILL. TECH CAMPUS.

The Chicago Offer

Is Chicago a more logical location for the Engineering Societies' Headquarters than either New York City or Pittsburgh?

Staff Report*

IS CHICAGO the logical location for the headquarters of the national engineering organizations? Can Chicago offer more than New York, the current Headquarters City, or Pittsburgh, which is also competing for the honor of housing them?

A move from New York is being seriously considered because the building at 29 West 39th St., in which the Founder Societies and a number of other national engineering organizations are now located has been greatly outgrown. The Engineering Societies Building has a usable floor space of about 90,000 sq ft, which is only half large enough to supply the space needed for the present staffs. This overcrowding makes it imperative that some arrangement be made for a new building.

A new building in some other Manhattan location is one possible solution. There are obvious advantages to remaining in the Metropolitan area. All of the staff members are residents of New York, and any move out of town would involve the loss of a number of experienced staff members who for personal reasons could not leave that city. Also, there are certain legal restrictions on the use, outside of New York State, of funds from the original Carnegie grant. The building now being used came to the Societies in the form of a trust given by Carnegie, and it is possible that the Supreme Court of New York could decide that this money (about $2 million) could not be taken out of the State. Further, a high percentage of the members of the councils and governing boards of the Founder Societies are from the New York area, and they would naturally oppose the movement of the headquarters.

Despite these very serious obstacles, both Chicago and Pittsburgh think they have more to offer than New York, and committees of engineers in each city are working hard to show the United Engineering Trustees, the governing bodies of the Societies, and the Society members the many advantages of a move to their particular area.

The Chicago story is an effective one. A quick look at the map and a rundown of Chamber of Commerce statistics show the many advantages of Chicago from the point of view of industry, transportation, hotel space, and educational and cultural facilities. No one questions the leadership of Chicago as a transportation center or as the convention center of the nation. The plane, train, and hotel facilities make it an easy city to get to and a pleasant one in which to stay. Its central geographical location makes not only transportation but communication by mail, telephone, or telegraph quicker and more economical in most instances.

Chicago is the world's largest industrial city, with a huge engineering population. There is no question but that the Societies would enjoy a considerable prestige in the Chicago community. It is also true that in the years ahead the Societies will be seeking

*Next month CE reports on Pittsburgh as a prospective headquarters city.—Ed.

more of their support and leadership at a distance from the Atlantic Seaboard. Industry is moving South and West. More than half of the nations accredited engineering colleges are located west of the Alleghenies, and in 1953, they enrolled about two-thirds of the country's engineering students, who will be the engineering leaders of tomorrow.

The second factor, that of economics, is being forcefully stressed by those behind the "Move to Chicago" program. A National Engineering Center would need land, buildings, and facilities. These facilities not only should include such physical utilities as heat, power, and water but technical facilities such as libraries, research equipment, and a technical environment. Chicago claims to offer these more completely and more economically than any other location.

For example, the Illinois Institute of Technology, the University of Chicago, and Northwestern have all offered free sites on their campuses. The Illinois Tech. offer, which is the one being most seriously considered, involves a five-acre site just outside the Loop. It is the area between 30th and 32nd Streets, west of State. This is in the development now known as Technology Center, and it is adjacent to the new buildings of Illinois Tech. This is one of the most accessible areas in Chicago, being only 20 minutes from the airport and less than 15 minutes from the railroad terminals. It is also just a short ride from the Conrad Hilton and other Loop hotels.

The Crerar Library, the world's most complete and finest technical library is now located in the Chicago Business district. It is understood that if an engineering center could be established in Chicago, this library would move to a site adjacent to the center so that the Societies' staffs and visitors to the Headquarters could have use of its more than a million technical volumes. The integration of the Societies' library, that at Illinois Tech., and the Crerar Library would provide not only the world's most outstanding collection of technical literature, but the combining of operating personnel would effect a sizable saving.

It is estimated that a 200,000 sq ft building of modern and efficient design could be erected on the ground offered by Illinois Tech. for less than $3 million. This is approximately a third of the estimated cost of a building in either Manhattan or in the Pittsburgh Golden Triangle. Even though Pittsburgh is offering a million dollars to the Societies if they will move there, the Chicago backers feel that their offer of land and the much lower building costs make their offer more attractive.

It is also being pointed out that there is not a better location in the United States for organizations which are heavily dependent on the mails and which buy considerable printing. Letters and publications from Chicago reach their destination faster, and Chicago is the world's largest and most diversified center for printing and publishing—an important consideration in view of the fact that all of the Societies publish large monthly magazines.

It would be very wrong for the governing bodies of the Societies not to give very full and careful consideration to the Chicago proposal. For many good reasons it does seem the logical location for the Engineering Societies, and Chicago's offer is a firm and generous one.

FINANCIAL BENEFITS OF THE CHICAGO LOCATION

Capital Benefits	*Estimated Value*
1. Approximately five acres of land for the headquarters building.	$ 500,000
2. Use of central heating system of Technology Center.	100,000
3. Use of food service facilities of Technology Center, sparing the necessity of installing and equipping a restaurant.	300,000
4. Opportunity to use central telephone switchboard of Technology Center.	30,000
5. Parking space facilities across the street from the proposed building.	100,000
6. Opportunity to use two auditoriums (both equipped with motion picture projection booths; one seats 360 people; the other, 225) and other meeting and conference rooms in Illinois Tech building.	100,000
Total Capital Savings Possible	$1,130,000

NOTE: The above figures only refer to capital savings possible at the time the building is erected. It is certain that substantial annual operating economies are offered by Points 2-4.

Other Savings and Services

1. Illinois Tech's buildings and grounds, refuse disposal, and delivery services will be available.
2. Its special police staff, now numbering 24 people, will be available.
3. Technology Center's own branch post office, its library, its bookstore, its chapel, and its shopping and services building will be within a few blocks.
4. Illinois Tech maintains a large "office services" department where offset, lithographs, multigraph, mimeograph, mechanical addressing and all mailing services are available at cost.
5. Also located at Technology Center is one of the nation's most complete electronic computing facilities. There is a wide range of IBM and Remington Rand equipment including digital and analogue computers and other devices whose use will be of value to the Societies.
6. Illinois Tech has completed construction of two modern apartment buildings within a block of the proposed Societies' building. Two more modern apartment buildings are under construction, and these will be ready for occupancy around January, 1955. Residential space is available in them for staff people at Technology Center.
7. Recreational facilities on the Illinois Tech campus will be available. Employees of the Societies will be welcomed to campus events, public lectures, exhibits, athletic games, and be within easy access to IIT evening classes.
8. Situated at Technology Center are sources of specialized information that may often prove of great convenience. Also, its students, teachers, and research people constitute a valuable reservoir of trained persons for the performance of special services. Members of their families, such as the wives of graduate students, will prove a convenient source of office personnel.

AUTHOR (STANDING) AND TWO ASSOCIATES WORK PLOTTING TABLE AND METERING DESK AT GEORGIA TECH.

Present and Future of

Network Analyzers

GEORGE P. WILSON
Electrical Engineer
Jackson and Moreland

Mr. Wilson was a consultant to power companies in his capacity as associate engineer in the power systems department of Illinois Institute of Technology from 1946 to 1950. He worked on problems of special network analyzer techniques and on matters regarding power systems planning and design. He joined Jackson and Moreland early in 1950, and has been assigned to power systems studies. His work involves frequent use of network analyzers; he has been in responsible charge of work on several analyzers installed at various locations.

POWER SYSTEMS EXPANSION in recent years has brought into focus the importance of the network analyzer. Except for a very simple system or for a small portion of a large system, longhand computations of load division, voltage regulation, or short-circuit problems are rapidly becoming impractical. Furthermore, the solution of problems in an extensive power network by longhand methods

would be economically unjustified when compared with the comparatively short time and low cost of a network-analyzer solution for the same problems.

Today's Problems

Rapid load growth has dictated the installation of large turbo-generator units. These large units, with their lower annual fixed charges per kilowatt and high operating efficiency, have reduced the production costs for each kilowatt hour of electrical energy, enabling power companies to maintain their allowable profit margin in the face of rising costs. Today, the point of diminishing returns has been reached by many companies, and rate increases are becoming necessary.

Because of this general situation, power companies must exert all means at their disposal to assure an economic approach to system expansion problems. Long-term system planning is the best means of accomplishing this. It can be very costly to await the onslaught of a critical power system expansion problem and only then adopt expediency measures in order to "get over the hump."

Power companies which previously have done little or no system planning are now forced to formulate their plans well in advance because of the time lag between the ordering and the delivery of new equipment. The alternative is to face serious and costly consequences.

Investigations should be initiated early and should be continued to insure that existing equipment is efficiently utilized and that new equipment (lines, transformers, switchgear, and generators) is available when and where it is needed. Area requirements must be met. Good over-all electrical performance of the system, at minimum cost, is essential.

Planning and Analyzers

Long-range system planning having been recognized by many companies as an economic necessity, many companies are investigating their system expansion problems on the network analyzer. Others will do likewise because of the many problems which are inherent in rapid load growth. The increased number of network analyzers placed in service in recent years — and the forthcoming ones — verifies the validity of these observations.

The total energy produced in the United States in billions of kilowatt-hours per year rose from 95 in 1929 to 400 in 1952. The deterring effects of the depression years and the war years on energy consumption have been erased, and the over-all rate of consumption shows a steady rise from 1929 to the present. The increases since 1946 have been surprising. The total number of network analyzers in service in the United States has correspondingly risen from 1 in 1929 to 26 in 1952. The first analyzer was installed at the Massachusetts Institute of Technology in 1929. It is still in service. The end of 1953 saw 27 in service, and by the end of 1954 there will be at least 30 of these machines in operation in the United States.

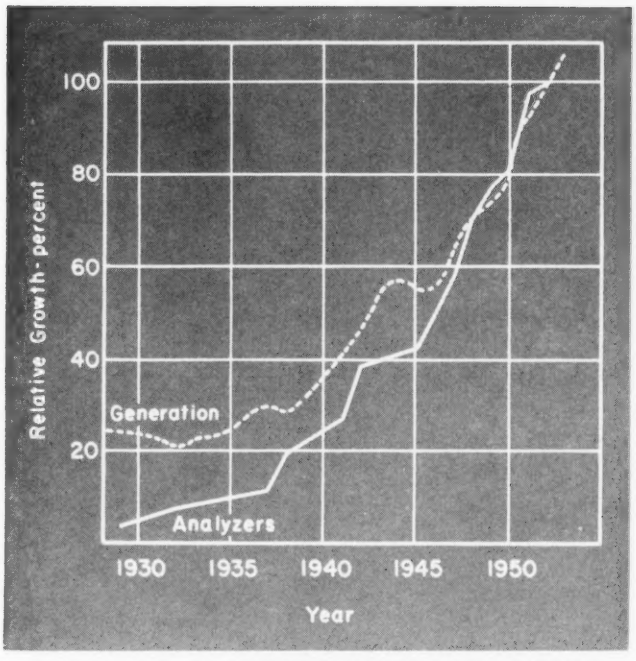


FIG. 1—USE OF NETWORK ANALYZERS CLOSELY PARALLELS INCREASING GENERATION OF ENERGY.

An interesting cause-and-effect relationship is apparent from an inspection of both trends. The total energy produced in billions of kilowatt hours per year has been plotted in Fig. 1 as a percentage of the total energy produced in 1952. A second curve shows the number of network analyzers in service in the United States as a percentage of the network analyzers in service during 1952. The generation curve shows that the load growth between 1929 and 1938 was not very great as a result of the financial depression. The second curve indicates quite clearly that there also were not many new network analyzers installed during that time.

Between the years 1938 and 1943 there was a substantial load growth which was accompanied by an increased interest in the use of network analyzers for the solution of power system problems. There was practically no load growth between the years 1943 and 1946. The curve indicating the number of network analyzers in operation is also quite flat during that same period. After 1946 the total energy produced in the United States increased tremendously. The number of network analyzers in service also increased by leaps and bounds during this period. It is expected that the number of network analyzers in the country will continue to increase. Existing network analyzer facilities will also be expanded as a natural consequence of load growth.

In the past, the network analyzers used by power companies have been located either on college campuses or at large electrical manufacturing con-

TABLE 1a — INFORMATION AVAILABLE FROM STEADY-STATE POWER-FLOW STUDIES

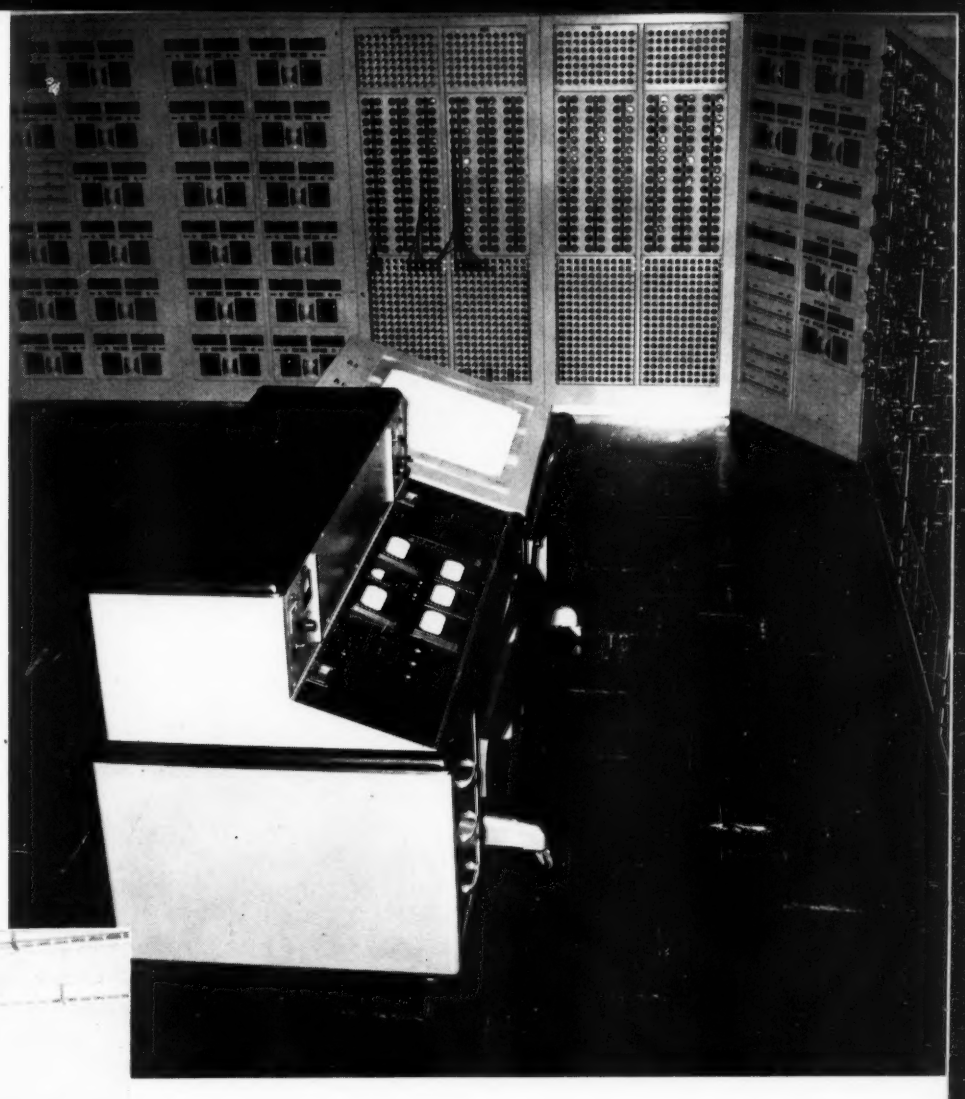
Generators	*Transmission Lines*	*Transformers*	*Synchronous (or static) Condensers*	*Substation Loads*	*Circuit Breakers*
Terminal voltage and phase angle.	Kw and kvar flow.	Best rating.	Capacity.	Effect of power factor.	Continuous current duty.
Internal voltage and phase angle.	Best location.	Kva load.	Kvar load.	Voltage and phase angle.	
Best location.	Best wire size and spacing.	Best tap range and setting.	Best location.	Effect of different load levels on system performance.	
Effect of outage.	Effect of new lines.	Effect of outage.	Effect on bus voltage.	Effect of load growth.	
Kw and kvar output.	Best operating voltage.	Kw flow.		Effect of new loads.	
	I^2R loss.	Kvar flow.			
	I^2X loss.	Effect of quadrature control on power flow.			
	Loss factor.	I^2R loss.			
	Regulation.	I^2X loss.			

TABLE 1b — INFORMATION AVAILABLE FROM TRANSIENT-STABILITY STUDIES

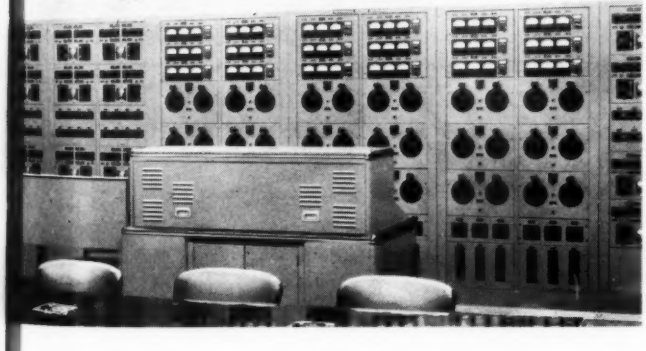
Generators	*Transmission Lines*	*Synchronous (or static) Condensers*	*Circuit Breakers*	*Relays*
Effect of changes in resistance.	Effect of switching time for various types of faults.	Effect of a synchronous condenser placed somewhere along the line.	Effect of high-speed reclosing.	Behavior during power swings.
Effect of high-speed excitation.	Effect of series capacitors.		Effect of selecting pole opening and reclosing.	
Effect of governor action.				
Effect of saliency.				
Effect of neutral-to-ground resistance.				
Effect of added generator capacity.				

TABLE 1c — INFORMATION AVAILABLE FROM SHORT-CIRCUIT STUDIES

Generators	*Synchronous (or static) Condensers*	*Substation Loads*	*Circuit Breakers*	*Relays*
Current contribution to a balanced or unbalanced fault.	Current contribution to a balanced or unbalanced fault.	Determination of voltage dip due to a fault.	Interrupting duty.	Determination of fault currents and voltages seen by relays.
			Momentary duty.	Determination of coordinated phase ground relay settings.
			Effect of bus-sectionalizing on breaker duty.	Effect of grounding schemes on ground relay settings.
			Effect of various station-bus arrangements on breaker duty.	Effect of ground wire and counterpoise.
				Effect of mutually coupled lines on ground relay settings.



THE NETWORK ANALYZER AT GEORGIA TECH (RIGHT AND BELOW) WAS FURNISHED BY WESTINGHOUSE. THESE VIEWS SHOW PANELS CONTAINING METERS, ADJUSTMENTS, AND CONNECTIONS. IN FOREGROUND (RIGHT) IS METERING DESK; PLOTTING TABLE IS LOCATED BEHIND IT.



cerns. Some power companies have found need for frequent use of a network analyzer and have weighed the merits of buying one themselves or entering into joint ownership with one or more other power companies. It is expected that power companies will be more inclined to purchase their own analyzers in the future, particularly if a reasonably low-cost unit becomes available.

For every company which would purchase its own analyzer or enter into joint ownership with others, there will be dozens which will do neither. This latter group will depend on obtaining scheduled time at existing, well-established network-analyzer laboratories. Here they can obtain the added benefits of an expert analyzer staff familiar with power system problems.

The problems which can be solved on the network analyzer can be listed as follows: steady-state power-flow studies; transient-stability studies; short-circuit studies; and special studies.

Some of the information which can be obtained from the network analyzer for those problems which fall in the first three groups is listed in Table 1. The information contained in this table is not intended to be all-inclusive, but it sets forth the general type of problem which can be solved on the analyzer.

Special Problems

In addition to this, there are many types of special problems which can be readily solved on the analyzer. The following list will indicate their general nature: determination of transfer and driving point impedances; determination of special types of equivalents for use in load flow and short-circuit studies; determination of power-angle diagrams; examination of voltage-flicker problems; and determination of system loss and incremental loss formulas. The loss formulas correlate incremental generating costs with transmission losses, helping to determine an over-all economic generator loading schedule.

Reclaiming Transformer Oils

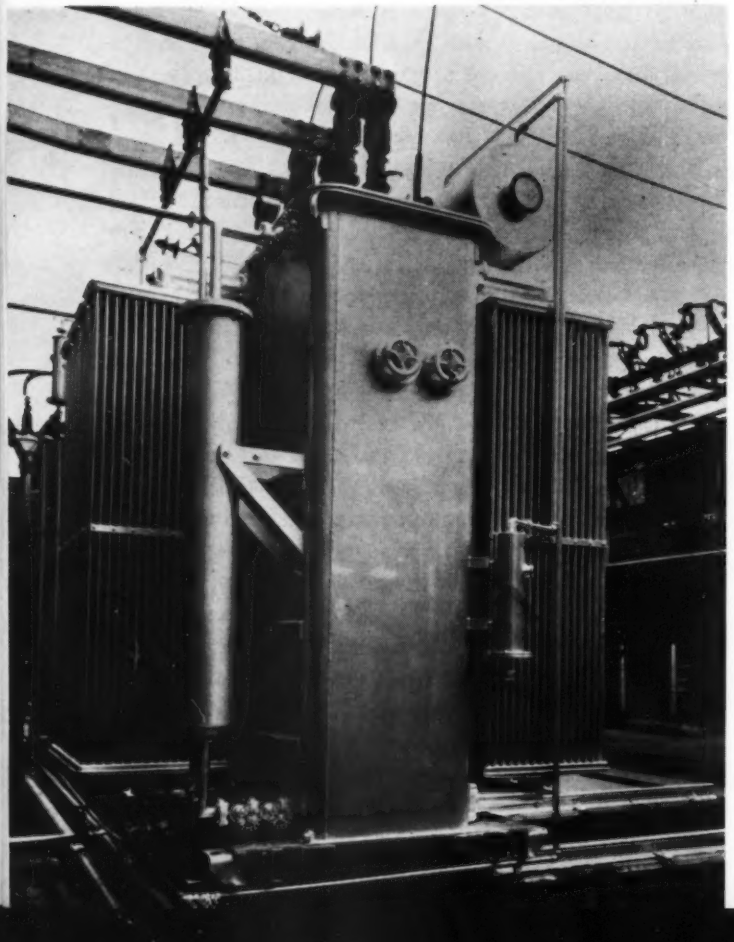
Bowser, Inc.

TRAILER-MOUNTED RECLAIMING UNIT IS SHOWN BEING USED ON AN ENERGIZED TRANSFORMER IN THE FIELD.

CE exclusive

AIR, MOISTURE, and heat are the principal enemies of transformer insulating oil. As the oil begins to deteriorate, organic acids are formed which attack and corrode power equipment. Further deterioration results in formation of a sludge which impairs the cooling action of the oil and lowers the efficiency of the transformer. In addition, free water formed as an oxidation product, as well as the moisture picked up from contact with air, cuts down insulating properties and promotes the attack of metal parts by water soluble acids. Water is usually found both in solution with the oil and in a free condition.

Aluminum Company of America



ACTIVATED ALUMINA THERMO-SYPHON TREATER AND BREATHER PROVIDE CONTINUOUS TREATMENT FOR OIL.

Dielectric strength is often considered the most important test for insulating oils. Although free carbon has some effect, this test is principally influenced by the amount of free water in the oil. When dielectric strength is insufficient, blotter presses or centrifuges can be used. These methods effectively remove moisture, as well as a considerable amount of sludge and other solids in suspension.

Improved Equipment

Many improvements recently have been added to increase the efficiencies of these methods. One unit, manufactured by Bowser, Inc., removes heavy solids by means of a disc-type filter. The oil is then passed through a high-pressure pump, heat exchanger, electric heater, and dehydration chamber. Separated volatiles and gases are removed by a vacuum pump. Finally, the oil is passed through a blotter press, which removes finely divided contaminant particles. Since the oil at this stage is free of moisture, the paper filters maintain their filtration efficiency for a longer period of time.

All equipment, including motors and controls, are mounted as one integral unit which can be used for batch filtration or, when mounted on a truck, can

be used in the field without removing the transformer from service. Capacities are up to 500 gph.

Since centrifuges do not remove finely divided carbon, blotter presses are sometimes used as a final treatment. The DeLaval Separator Co. mounts a centrifuge and blotter press, together with heater and controls, on one platform for mounting on wheels or on a truck.

Although blotter presses and centrifuges do effectively remove moisture and insoluble contaminants, they are not capable of removing such soluble contaminants as acids and asphaltenes. Consequently, the oil will continue to deteriorate and deposit sludge. In addition, unless the soluble contaminants are removed, the oil will quickly pick up more water, thereby reducing the dielectric strength.

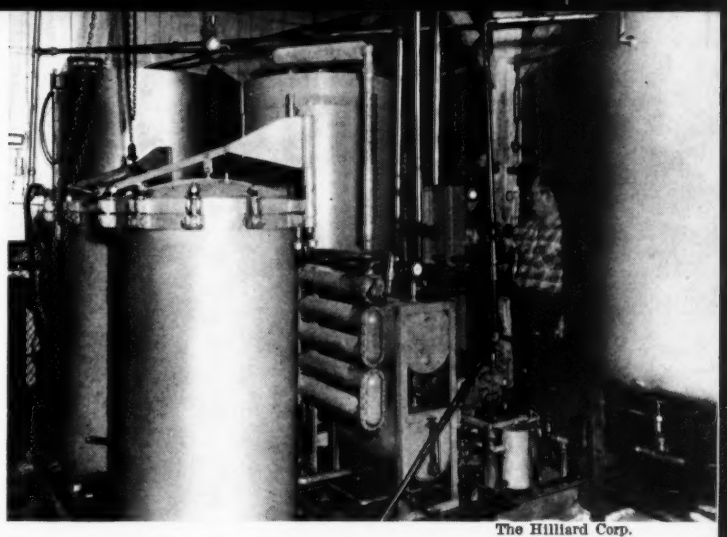
Many companies are finding it necessary to operate transformers at increasingly higher loads—with subsequent rises in the temperature of the insulating oil. Much of the deterioration of oil is chemical reaction, and rate of the reaction doubles for approximately each 18 F rise. In addition, catalytic action accelerates the growth of deterioration products. This condition is still further aggravated because water solubility of oil increases as the oil deteriorates and as temperature increases.

Tests

One indication of oil condition which can be used effectively as a single-screening test is power factor. A low power factor usually means that little can be wrong with the oil, while a high power factor indicates that further tests should be made.

Chemical condition of the oil can be measured by neutralization number and interfacial tension tests. The neutralization test has been used with success for many years. Although opinion varies as to how high a neutralization number can go before the oil reaches the point where it will start precipitating sludge, most companies consider approximately 0.4 to 0.6 as approaching the danger zone.

The interfacial tension test is generally accepted as a yardstick to indicate the sludging tendency of the oil. Oil deterioration products are classified as polar molecules, and a low interfacial tension indicates the presence of polar molecules. Interfacial tension can be used as a single test for chemical condition, if desired, since experience has indicated that although there is no direct relationship between the two tests, the neutralization number will be acceptable if interfacial tension is at a satisfactory level.



The Hilliard Corp.

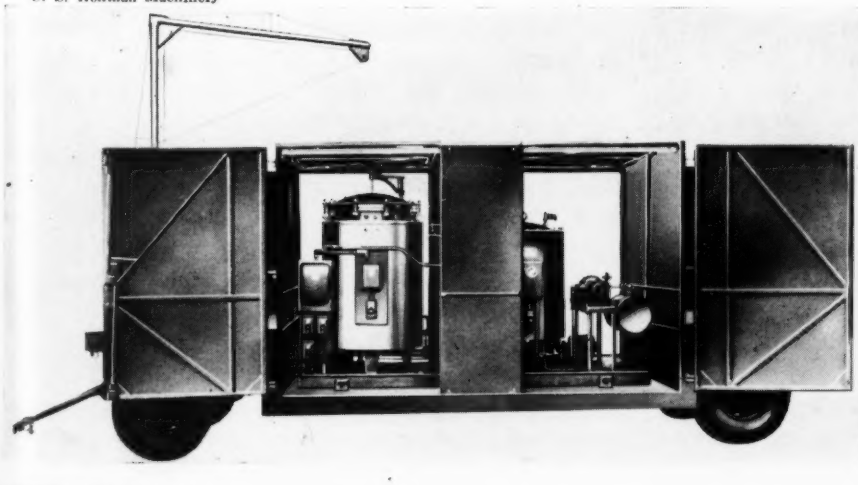
STATIONARY INSTALLATION HAS CLEAN OIL TANKS BEHIND RECLAIMERS. DIRTY OIL TANK IS AT RIGHT.

Reclaiming Equipment

Several manufacturers have reclaiming units designed specifically for power system oils, and incorporating an adsorbent process for removal of both soluble and insoluble contaminants. Fuller's earth is the most widely used adsorbent medium. Two pressure-type filters are often provided to permit changing charges without taking the filter out of operation. The two filters are normally used in series, the oil being passed through the oldest charge first. Use of series operation has been found to be the most economical, since tests have shown that after being used once, the fuller's earth will not reduce impurities to the same extent as it did the first time, but is capable of removing some contamination.

Most of the units also are furnished with a means for dehydrating the oil after it has passed through

U. S. Hoffman Machinery



THIS HIGH CAPACITY RECLAIMING UNIT IS MOUNTED IN A VAN DESIGNED TO TRAVEL CROSS-COUNTRY ALONG THE POWER LINES. PLATFORMS, HIDDEN FROM VIEW BY THE DOORS, ARE PROVIDED FOR CARRYING FILTER MATERIALS AND SUPPLIES.

the filters. This may be either a blotter press or a vacuum dehydrating unit.

Some reclaiming units are built for stationary service in central locations, while others are designed to be transported to the transformer. Since setting up portable equipment in the field prior to operation usually requires an hour or so, some companies find it economical to drain small transformers (500 gallons or less) and transport the oil to a central filtration plant.

In-Service Treatment

In some instances it is impossible to remove the transformer from service. In recent years, portable reclaiming units equipped with safety features to permit treating the oil in energized transformers have been used with considerable success. Reclaiming the oil in the field also eliminates the need for transporting huge quantities of oil, and the clean oil circulating through the transformer has a solvent action on old deposits and acid oxidation products which would not be flushed from the transformer if the oil were simply drained. Dirty transformers can be improved considerably by repeating this purification practice several times at one year intervals.

Recently, U. S. Hoffman Machinery Corp. announced a trailer-mounted reclaiming unit called the Filtermobile, designed specifically to travel cross-country along the power lines. It consists of a large van with doors to keep out dust and weather when in transit. Platforms at each end carry filtering supplies and transformers to reduce line voltage for operation of the equipment.

The filtration equipment consists basically of a cartridge type filter using repackable fuller's earth cartridges and a vaporizer with necessary controls and piping connections. Units now being manufactured feature capacities as high as 1800 gph.

The Honan-Crane Corp. offers self-contained filtration plants consisting of fuller's earth filters and vacuum dehydration and degasification units together with all necessary heating units, controls, pumps, piping, and accessories, conveniently arranged on a floor truck or skid. A number of these units have been mounted in trucks or on trailers for use in the field. Self-contained units of this type are available in capacities up to 600 gph.

The Hilliard Corp. has reported that one of its self-contained reclaiming units also has been mounted on a truck and has been successfully used in field service for almost two years. This unit consists of repackable filters, vaporizer, heat exchanger, built-in pumps, electric heaters, and controls.

Economics

Operating experience reported by one manufacturer of reclaiming equipment shows that on large quantities of oil, ranging from 0.50 to 1.00 neutralization number, the average consumption of fuller's earth can be expected to be about 0.75 pounds per gallon of oil. Loss of oil in reclaiming is about 5 percent if the charge is permitted to drain completely before dumping. The operating cost comes to slightly under 10 cents per gallon, including interest, taxes, depreciation, maintenance, materials, and labor. The total cost is about ¼ that of new oil delivered in drums, and less than ⅓ that of new oil hauled in bulk from the refinery. This is based on present prices for oil and a cost of 3.5 cents for fuller's earth in bulk.

It should be recognized that reconditioning oil is not the most economical procedure in all instances. Accelerated oxidation tests show that reclaimed oil is not as resistant to further oxidation and deterioration as new oil.

Oxidation inhibitors can be added to reclaimed oil, however, to make it much more resistant to oxidation and to extend its life to many times that of new uninhibited oil. The inhibitor most commonly used is known as DBPC, di-tertiary-butyl-paracresol, marketed by Koppers Co. DBPC is available as a solid which must be completely dissolved before adding to a transformer, or it can be purchased in a solution of oil under the trade name Impruvol 20. This inhibitor is not removed by fuller's earth treatment at temperatures lower than 180 F, or by methods commonly used for dehydration or degasification.

Activated Alumina

A somewhat different program for oil maintenance, recommended by the Aluminum Company of America, uses Activated Alumina as the adsorbent medium. This method involves equipping transformers or other oil containing equipment with a continuous treater, so that the oil passes slowly through the bed of Activated Alumina. This can be accomplished in most instances by attaching a thermo-syphon, by-pass treater to the equipment. The oil circulates through these relatively inexpensive treaters as a result of the difference in temperature between the oil in the treater and the oil in the equipment.

Maintenance is confined to replacement of the alumina when tests show that it has become ineffective. Replacement intervals vary from one to four years. The alumina can be reclaimed for further use if desired.

To increase the efficiency of the by-pass treater, a breather containing Activated Alumina can be attached to the transformer to remove moisture from any air contacting the oils.

A transformer maintenance program of this type has been in operation for a number of years at the Alcoa, Tennessee Works of Aluminum Company of America. Performance records at this plant indicate that a maintenance program using Activated Alumina and continuous treaters, when carefully applied to a power system, costs less than $0.01 per gallon of oil per year.

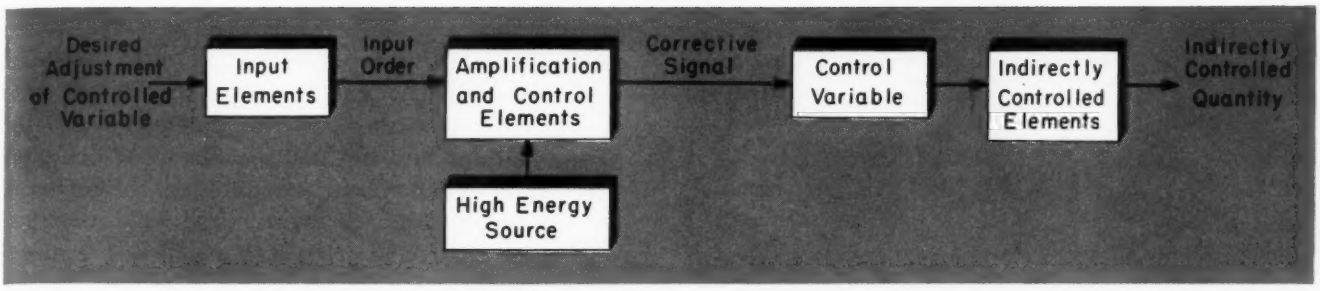


FIG. 1 — BLOCK DIAGRAM REPRESENTS GENERAL FORM OF OPEN-LOOP CONTROL SYSTEMS. THE LOW-ENERGY INPUT ORDER COMMANDS THE HIGH ENERGY; INPUT HAS NO KNOWLEDGE OF HOW WELL OUTPUT IS OBEYING.

Principles of Feedback Control

JULIUS Y. KAPLAN
Head, Servomechanisms Section
Arma Corporation

SIDNEY DAVIS
Chief Development Engineer
Servomechanisms, Inc.

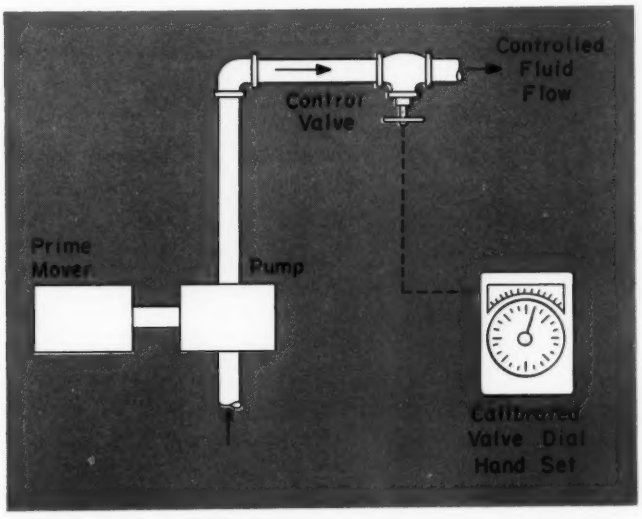


FIG. 2 — AN ACTUAL OPEN-LOOP SYSTEM, WHERE VALVE SETTING CONTROLS FLOW OF THE FLUID.

WHEN A LARGE amount of energy is directed by a small amount of energy to achieve a desired result, control exists. The small amount of control energy may involve operation of a light switch, stepping on an automobile accelerator, setting a thermostat, or synchronizing a 5000-kva generator. In each instance, a large block of energy receives an "instruction" to start or stop, to work, or to change pace.

A Twentieth Century tendency has been to reduce control to the manipulation of buttons, knobs, and levers. In fact, many people erroneously tend to associate this manipulation with the control process itself, forgetting about the complex system on the other side of the panel.

Engineering and Control

The relation between engineering and the control process is intimate. There must be a link between the low-energy control order and the precise regulation of large power blocks. This link is the control system. Because of increasingly tighter precision and response speed requirements, control systems engineering is rapidly increasing in importance. In

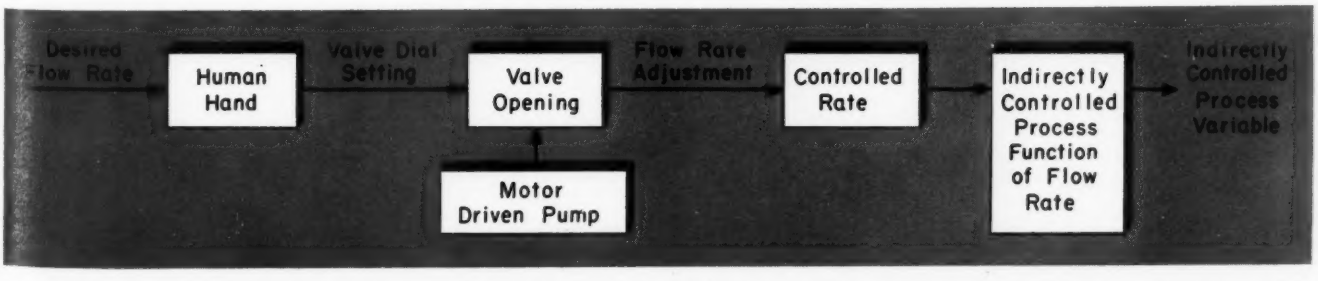


FIG. 3—THIS BLOCK DIAGRAM REPRESENTS THE OPEN-LOOP SYSTEM OF FIG. 2 TRANSLATED TO THE GENERAL FORM OF FIG. 1. THE TWO BLOCK DIAGRAMS SHOW THE CORRELATION BETWEEN THE SPECIFIC AND GENERAL CASES.

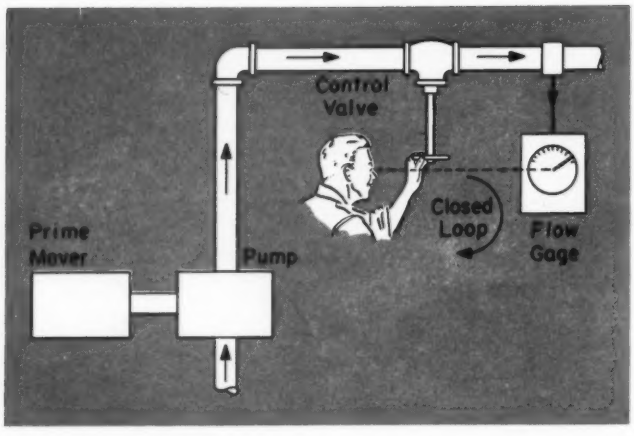


FIG. 4—CLOSED-LOOP USES A MAN TO CHANGE INPUT IN RESPONSE TO ERRORS IN OBSERVED FLOW.

the last few decades or so, control system design has been changing from an art to a science. Mathematical methods permit precise formulations of concepts which hitherto had fallen under the headings of experience and intuition—trial and error. On the other hand, the mathematical representation of component characteristics frequently poses difficult problems, particularly in the case of manual and semi-automatic systems where human "components" are interconnected with machines.

Control Modes

There are two distinct and important modes of control: open-loop and closed-loop. The open-loop is essentially a series connection of calibrated elements, converting an input order at one end to a proportionate response at the other. The controlled output may be a machine or a process variable. The input is in no way aware of the output's response to the input's orders.

Closed-loop control is based upon comparison of the input order with the controlled output variable. The error between actual output and the desired output is amplified. The amplified difference is fed back to the input-controlled variable in such a way as to enforce the output's obedience to the input order. By such feedback, the error signal serves to correct any error in the system response.

Fig. 1 shows an open-loop control system in a general form. A desired value of controlled variable is inserted and transformed into an input order. A series of tandem control elements amplify the energy level and apply the amplified energy as a modification of the controlled process or machine. Frequently the variable under control may, in turn, influence another quantity which is actually the desired end result. For example, controlling the oxygen content in a blast furnace governs the iron's quality.

All open-loop control systems can be put into the general form of Fig. 1. The specific character of the variables do not affect the basic control relationships. Open-loop systems are characterized by simplicity, directness, and stability. Their very simplicity makes for long life and easy maintenance. They are inexpensive. However, for accurate control, they have severe limitations. Fig. 2 is a pictorial representation of a simple open-loop system for the control of fluid flow rate. It consists simply of a motor-driven pump and a calibrated valve; a flow rate corresponds to each valve setting. The analogy to the generalized system of Fig. 1 is shown in Fig. 3.

The accuracy of open-loop control depends on the calibration of all tandem elements. In the above illustration, error may be introduced as a result of the following factors: variations in pump speed, corrosion in the piping, valve wear, temperature changes in the controlled fluid, leaks, or pipe clogging. In the face of these factors, precise setting and accurate maintenance of calibration becomes formidable, if not impossible.

This example emphasizes the main fault of open-loop control. Dependent as it is on an initial calibration, it cannot adapt itself to varying operating conditions. It has no means of either recognizing or correcting its errors.

A simple means for improving the control system in Fig. 2 would be to include a flow gage. Then an operator stationed at the valve could correct ob-

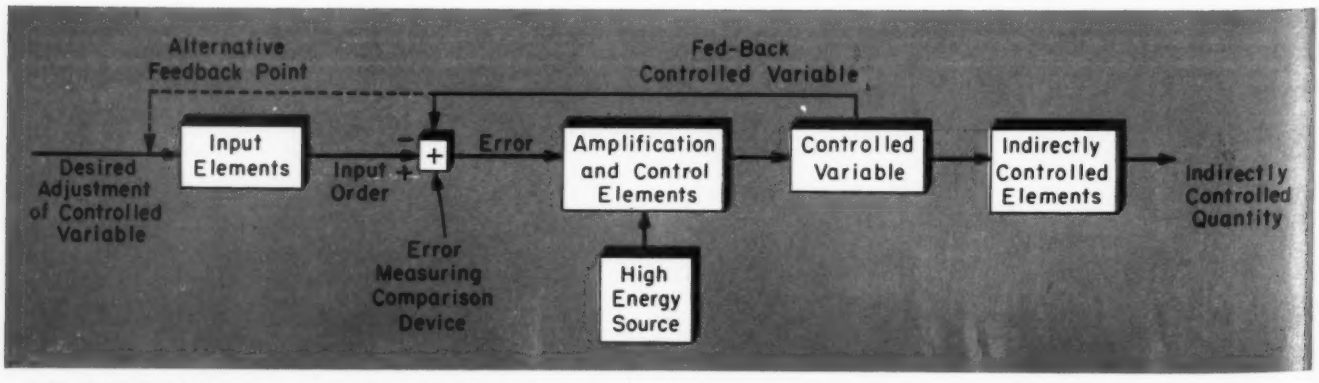


FIG. 5—THE CLOSED LOOP SYSTEM IS CHARACTERIZED BY COMPARISON DEVICE WHICH SENSES ERROR BETWEEN COMMANDED AND ACTUAL VALUES OF THE VARIABLE. ERROR IS FED BACK TO DRIVE SYSTEM TO ELIMINATE ERROR.

served errors in flow rate. Under these conditions, the control is no longer open-loop. The operator and flow gage provide a semi-automatic closed-loop system, Fig. 4. The system may be made fully automatic by replacing the operator with a detection device which observes flow rate, compares it with the input order, and modifies valve settings until the rate called for matches the actual rate of flow.

Feed Back Corrective Signal

As with the open-loop, it is possible to draw a generalized diagram which applies to all closed-loop systems, regardless of the nature of the variables, (Fig. 5). In this diagram, there is only one functional box which does not appear in open-loop control—the error measuring device. The device compares the response of the controlled variable with the input order. It feeds back the amplified

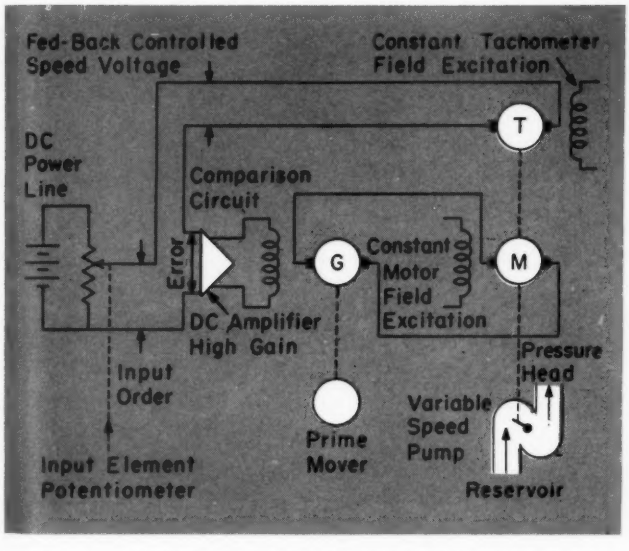


FIG. 6 — TACHOMETER MONITORS SHAFT SPEED; ERROR SIGNAL CORRECTS GENERATOR FIELD FLUX.

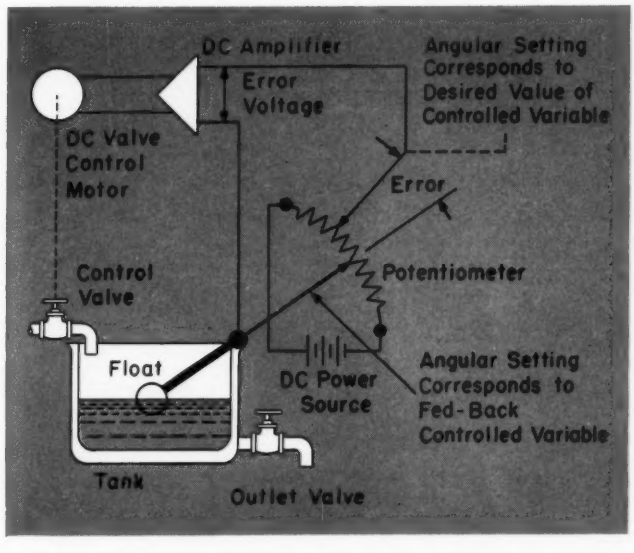


FIG. 7 — ERROR SIGNAL HERE IS DERIVED FROM FLOAT POSITION THROUGH USE OF POTENTIOMETER.

difference, or error, as a corrective action signal to the controlled quantity, forcing action in a direction to reduce the error. This corrective action is applied as long as a detectable error exists.

Closed-Loop Accuracy

Accuracy in this system is determined by two factors. The first is the tolerance of the flow gage and of the comparison device; this may easily be less than one or two percent. The second factor is the amplifier gain, which determines the minimum error to which the control valve adjustment will respond. If high amplification is provided, a small error could initiate valve correction.

In high-gain systems, over-all accuracy approaches that of the gage used. This is a highly significant characteristic. As long as amplification is high, flow rate is independent (over a wide range of variation) of the characteristics of the pump, the pipes, the valve, and calibration. Thus, relatively crude equipment of high power rating may give top performance by combining feedback of error information from an accurate measuring and comparison element to the control element.

Fig. 6 shows how feedback may be used to convert the control of a Ward-Leonard system to a system capable of regulating pump speed within 0.25 percent. In this system, speed orders are provided as in an open-loop drive. However, an additional element, a precision tachometer, generates a voltage accurately and in proportion to pump speed. The tachometer is inserted in a feedback loop where its output is compared with the input order voltage. When the output speed equals the value indicated by the speed order, the amplifier input is zero.

However, should any difference in voltage exist, voltage will be applied to the amplifier; the amplifier output acts through the generator to bring speed to its correct value. The precision of this closed-loop system depends upon the accuracy of the measuring and comparison element (the tachometer), and is relatively independent of the characteristics of the motor-generator set, the drive motor, or the pump load.

For best results in applying feedback, a systems viewpoint is essential. Consider again the flow control problem. Assume that the fluid is being delivered to a process and a definite flow rate ratio is required between controlled fluids. Since the critical variable is the ratio, it is clearly more advantageous (if possible) to feed back the ratio for comparison with the input order. (Additional feedback

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Department of Business and Economics

and

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A CONSULTING FIRM—nationally known—decided in recent weeks to expand its activities by adding to its staff of experts in the field of equipment and replacement policy. This action emphasizes the belief of the firm that management has much to gain through a re-examination of the way in which money is spent on capital goods—expenditures totaling tens of billions of dollars annually. All too frequently such expenditures are made by guess or by rule-of-thumb techniques. Sometimes they are subjected to even less scrutiny than many housewives use in buying the family groceries.

Importance of Equipment Policy

It is easy enough to demonstrate the importance of a sound and forward-looking policy in the acquisition and replacement of equipment. The competitive position of a business depends on its ability to keep costs down; efficiency in production is possible only when good use is made of modern technology. Every year sees the development of new machinery, improved methods of production, and new ways of doing things. Enterprises which keep abreast of these advances are the enterprises which reap rewards in the form of sound profit positions.

What is not always so clear is the fact that an up-to-date equipment policy on the part of American industry is an important guarantee of the well-being of the economy as a whole. It is often claimed that "Every time a new machine is installed it means fewer jobs." Coupled with this may be the statement, "We're doing well enough as it is, so why change?" This may be an easy policy in the short run, but it is in reality a policy of stagnation and not of progress. Fortunately, it has not been the policy of American industry as a whole.

Economists like to divide the factors of production into three groups: natural resources, labor, and capital. They mean that the goods people want and need are produced by combining natural resources, the labor of men's hands and brains, and the tools and machines—whether modern or primitive—that have been developed over the centuries. An increase in the amount and quality of any of these factors can be expected to lead to an increase in over-all production potential.

With only 7 percent of the world's people, the United States turns out about 50 percent of the world's goods.

Since 1900, total annual output in this country has been multiplied 4 to 5 times. Our material standard of living has doubled in the past 50 years. During the same period, reductions in the length of the work day and the work week have provided new leisure for millions of wage earners.

A major portion of this progress must be attributed to the growth in capital equipment. It is this growth which explains, in large part, why the output per worker has increased at an average rate of 2 percent a year and why productivity has risen at an average rate of 3 percent a year for the past 15 years.

Rising Standard of Living

In the United States, a rising standard of living has gone hand in hand with expanding productivity. Wage rates, for example, rose 130 percent during the past fifteen years while retail prices rose by only 89 percent. A further rise in productivity would mean further advances in comforts and luxuries—in the material objects which can contribute to a richer and more abundant life.

This is why, in the long run, labor-saving through mechanization in industry works for the benefit of labor as well as management. In the final analysis, the standard of living of any nation can be only as high as its ability to produce. Human wants are never satisfied. As we reduce the amount of labor necessary for the production of each unit of output,

we free such labor for the expansion of total output. After we provide the basic necessities of life, we find ourselves in a position to satisfy man's desires for a life above the subsistence level.

Future Outlook

Just as the present productivity of the United States is one of the most significant political and economic facts of the present, so its continued economic expansion will have enormous impact on the future course of events. Rising productivity can enable us to provide a rising standard of living for our population while continuing to meet the heavy financial responsibilities imposed by current international tensions.

True, not all our problems are those of production. Just as some of the best things in life are non-material, so material growth is not the sole consideration for a nation. But growth in material well-being can provide the atmosphere in which other problems can also be solved. Just as all have enjoyed the economic gains of the past, so future gains will accrue to the benefit of all.

Some reassuring forecasts have been made for the future. Careful observers have predicted that the years to come will witness gains in productivity comparable to those of the past decade and a half. The predicted economic expansion can occur only if American business remains, as it has been in the past, equipment minded. Stand-pat policies will not enable us to meet the challenges of the future.

The engineer thus has an important role in future developments. His work must be a bridge between the discoveries and inventions which will continue to come forth and the industrial concerns where they can be applied. Science and technology are not sufficient; they can serve us only to the extent that they are actually used.

Systematic Analysis

They cannot be used if "hunch" or guess work is the basis of equipment decisions. Horse and buggy methods of business planning are not suited to the world of today. A modern enterprise has a responsibility both to its owners and to the country to provide for systematic and regular equipment analysis. Management is obliged to maintain a continuous struggle against obsolescence, by keeping abreast of current developments and improvement. They must make decisions about equipment on the basis of complete information and of careful and scientific methods of comparing production alternatives.

This will be a useful contribution to the continuance of the free enterprise system, to a rapid increase in our standard of living, and to insuring the welfare of the nation.

Capital Goods Roundup

THE NATION'S capital goods activity is expected to total $58 billion for 1953, according to projections of studies by the Council for Technological Advancement. This figure includes production, transportation, distribution, and servicing of capital plant and equipment. The figures for 1953 are projected from the Council's study of the size and structure of the American capital goods industry for the year 1952.

The breakdown for 1952 shows that $54 billion was expended on capital plant and equipment; $35 billion of this went for equipment, $12 billion went for construction, and $7 billion went into servicing, maintenance, and repair. The employment figures for the period show 8.1 million persons working as follows: 4.8 million in manufacturing equipment, 1.9 million in construction, and 1.4 million in servicing. Employment for 1953 is expected to reach 8.25 million.

Employment Levels

Employment in the capital goods industries accounted for 16 percent of the persons working in manufacturing industries in 1952. The total number of employees in this field exceeds the next highest group — food and kindred products — by 71 percent; it exceeds the levels of the primary metals industries by 99 percent. But the makeup of the capital goods industry shows no singularly dominant group. The largest — electrical generating, transmission, and distribution machinery and apparatus — represents 14 percent of the total. The business automotive vehicles group is a close second.

Capital Goods Stock

The nation's gross stock of plant equipment valued at 1952 prices was about $500 billion. Maintenance and repair of this aggregate national asset ran up a bill of $6.8 billion in that year. Construction accounted for $11.9 billion of the year's capital goods production. New productive equipment represented an outlay of $35.1 billion. The 1952 expenditures for maintenance, construction, and equipment comes to $53.8 billion.

Reflecting on the findings of its study for 1952, the Council for Technological advancement says, "A level of productive activity totaling $54 billion and the creation of 8.1 million jobs are clear testimony that capital goods, indeed, form the 'keystone of national welfare.' "

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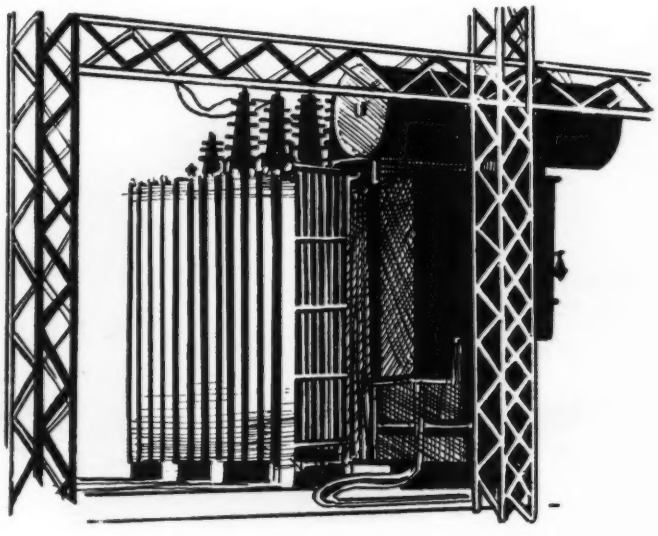
Stone and Webster Advises Against Use of Foreign Electrical Equipment

IN A REPORT on the United States electrical manufacturing industry and its relation to the security, health, safety, and welfare of this country, Stone & Webster Engineering Corporation warns that if U. S. utilities incorporate foreign-built electrical equipment in their systems, they could face serious emergencies because of substantial delays and expense that would be incurred in the overhauling and replacement of that equipment. These delays may be anticipated "as a result of numerous unsatisfactory experiences with foreign-built equipment in Latin-American countries in World War II."



Field Service

The report states that U. S. electrical manufacturers maintain extensive field service organizations, and in times of emergencies the manufacturers are able to mobilize the personnel and equipment of these organizations, together with materials from their many facilities, often in accordance with previously developed disaster plans.

The 1938 hurricane on the Eastern Seaboard and the 1951 flood in Kansas City are cited as examples of disasters where the ability of the industry to quickly restore electrical service to the area was invaluable in lessening the effect of the disaster.

If foreign equipment had been involved, however, the "great distances between manufacturing plant and site location of equipment and the absence of large service forces available for concentration in a given area would have resulted in a substantially longer disruption of local life and economy, and substantially greater financial and economic losses than actually occurred."

Of importance, with respect to the field service organizations of U. S. manufacturers, is their ability to maintain and repair equipment manufactured by their American competitors. Such a practice is possible because of a high degree of standardization for maintenance and production methods, and because of the familiarity which each manufacturer has with his competitor's products.

Stone & Webster warns that a "corresponding ability by U. S. manufacturers to maintain or repair foreign-built equipment does not exist for a number of reasons, including differences in basic design and manufacturing practices."

In discussing the development of new and better equipment, the report states, "The research, development, and planning service so essential to the continuing expansion and increased availability of power in the United States is supported by the sale of electrical products. Such service is not available in this country from others than the U. S. electrical manufacturing industry. Foreign manufacturers do not incur a proportionate share of the cost of this research, development, and planning service and are therefore in a favorable position in competitive bidding if price alone be considered."

Quality

With respect to quality, the study indicates that U. S. equipment generally is capable of operating above capacity—a significant factor in the outstanding performance of American industry during World War II. In comparison, "It is the generally accepted opinion of engineers in the United States that foreign manufactured equipment does not have the capacity or reliability of equipment made in the U. S.

In summing up the findings of the study, Stone & Webster predict that "If very much essential electrical equipment is purchased from foreign manufacturers for installation in the United States, some reduction in the rates of expansion and the rate of operation of American industry and of agricultural and civilian use of electric power can be expected."

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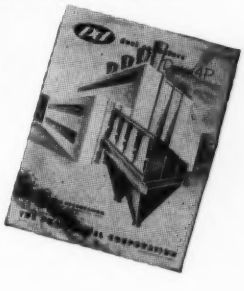

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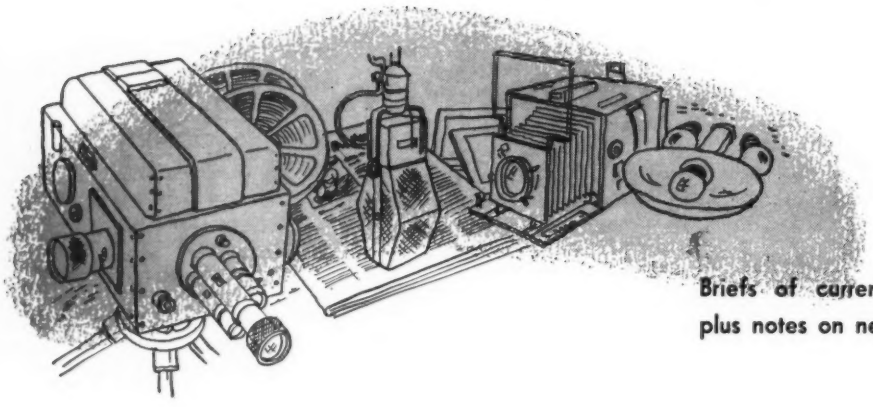
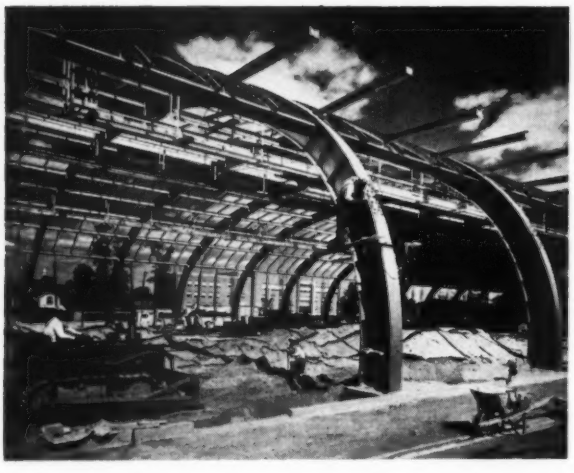


NEWS

Briefs of current interest to the consulting profession plus notes on new equipment in the field of engineering



University Utilizes Latest Building Techniques

Latest addition to Connecticut University's expansion program is a spacious fieldhouse now under construction at an estimated cost of $930,000. Designed by Frederick C. Teich of Hartford, Conn., the structure has benefited by up-to-date building techniques.

The building, elliptical in section, is 343 ft long, 150 ft wide and 40 ft high to accommodate basketball courts, squash courts, equipment, and lecture rooms. It will have a seating capacity of 5000.

Construction of the fieldhouse proper consists of 14 rigid steel frames with a span of 150 ft. Exterior walls are architectural concrete, polished granite for main entrances, and face brick. The roof is steel purlined and covered with Wheeling Corrugating Company's Tri-Rib roof decking with interlocking edge ribs and stiffening ribs, the whole covered with four-ply built-up roofing over one inch insulating board.

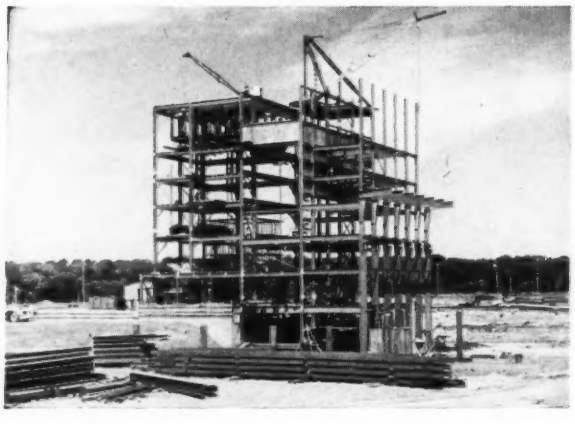
One of the principal features of the steel roof decking is speed of handling. A four man crew, two welders and two erectors, can lay 4000 sq ft in a day.

The decision to design the fieldhouse in steel rigid frame was from a viewpoint of economy in material and erection. Earlier construction on the same campus, used for similar athletic purposes, proved to be the most suitable and economical.

The entire job is under supervision of the Associated Construction Co., Hartford. Structural engineer on the project was Robert W. Loomis, Windsor, Conn.; mechanical and electrical engineers were Hubbard, Lawless & Blackeley, New Haven. Structural steel was fabricated and erected by City Iron Works, Inc.

Corrosion Course to Be Held At Washington State College

This year's annual short course in corrosion sponsored by the National Association of Corrosion Engineers will be held on the campus of Washington State College. The five-day course, February 1-5, 1954, will include five general topics: fundamentals, practical aspects, corrosion mitigation, materials of construction, and environment.



Crane on Roof Hoists and Sets Structural Steel

Working from wooden mats spanning the framework on the roof of a boiler building, a Lorain TL crane, hoisted and set structural steel from a point 140 ft above ground. Owned by the Hart Construction Company of Omaha, Nebraska, it also was used to assist in the boiler assembly. The Thew Shovel

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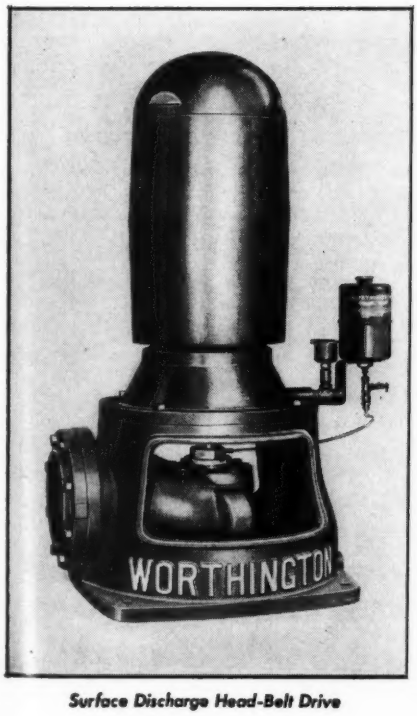
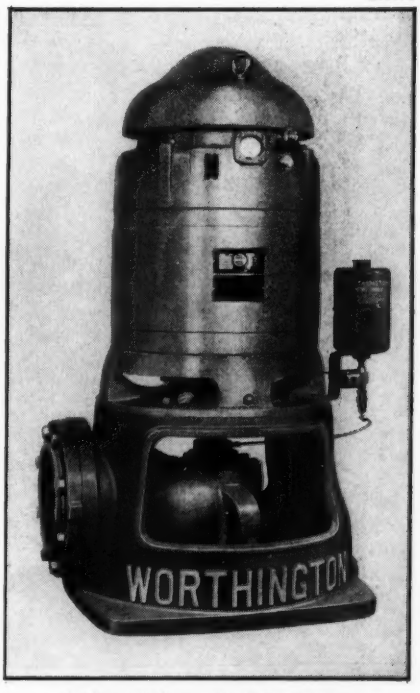


Surface Discharge Head-Belt Drive

Surface Discharge Head-Right Angle Gear Drive



Surface Discharge Head-Motor Drive

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Crane Hoists Steel

—*Starts on page 54*

Company crane was raised in two sections to the top of the building by a "stiff leg" crane.

The building, shown under construction, will house a 110-ft-high, 575,000-per-hr capacity boiler. For use at the new $17 million North Omaha Plant of the Omaha Public Power District, the boiler, made by Combustion Engineering Corporation, is capable of operating a 75,000-kw generator.

Transition Piece Eliminates Need for Butt Weld

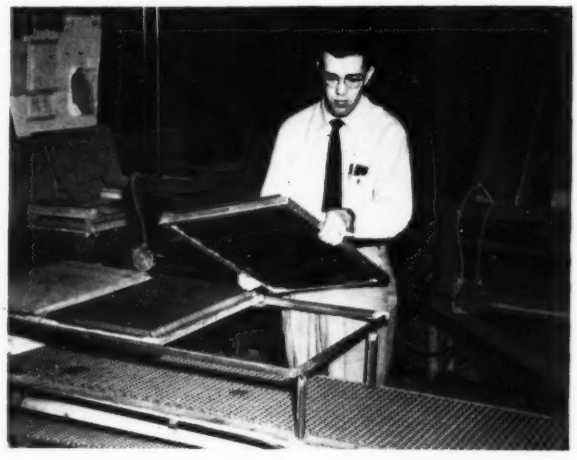
For use in England on ultra high-temperature, high-pressure steam systems, bi-metallic Kelcaloy transition pieces, made by the M. W. Kellogg Co., will be used to connect ferritic throttle valves with austenitic steel main steam piping.

In England the design practice is the reverse of that used in this country. Chrome-moly is used for the valve and hook-up to the steam chest, while stainless steel, because it may be designed for thinner walls, is used for increased flexibility in the main steam piping.

The basic reason for the use of transition pieces lies in designers' reluctance to join by a butt weld two metals of widely varying thermal coefficients of expansion. The transition piece eliminates the need for welding these different materials together. In the Kelcaloy process austenitic steel is integrally bonded to a ferritic chrome-moly forging to provide a transition piece which is of the desired chrome-moly steel at one end, and austenitic stainless at the other, and having a central transition bond of controlled axial length.

WAREHOUSE IS WRAPPED IN GLASS

Two layers of Fiberglas, each four inches thick, are shown being applied to the walls of the Pasco Packing Company's new warehouse at Dade City, Florida. This freezer warehouse, one of the largest in the nation, will store up to 5,625,000 gal of frozen citrus fruit concentrate. Nearly 2½ million board feet of the insulation manufactured by Owens-Corning Fiberglas Corp. was needed for the walls, roof, and floor to maintain temperatures of 15 degrees below zero.



Radiant Heating Panels Assure Uniform Temperature

Radiant heating panels designed and constructed specifically for industrial application offer an improved concept in infrared heating. Long-wavelength black-body radiation from an area source assures temperature uniformity over large areas and maximum heat absorption, regardless of surface texture or color of the material being treated.

They are suitable for operation at temperatures as high as 350 C and range in watt densities from 2.6 to more than 9 watts per sq in.

The heating element, uni-directional and backed with an aluminized steel reflector, operates without additional insulation, minimizing installation and maintenance costs. The large radiating area makes possible a high power output while element temperatures remain at a relatively low level, substantially reducing the fire hazard.

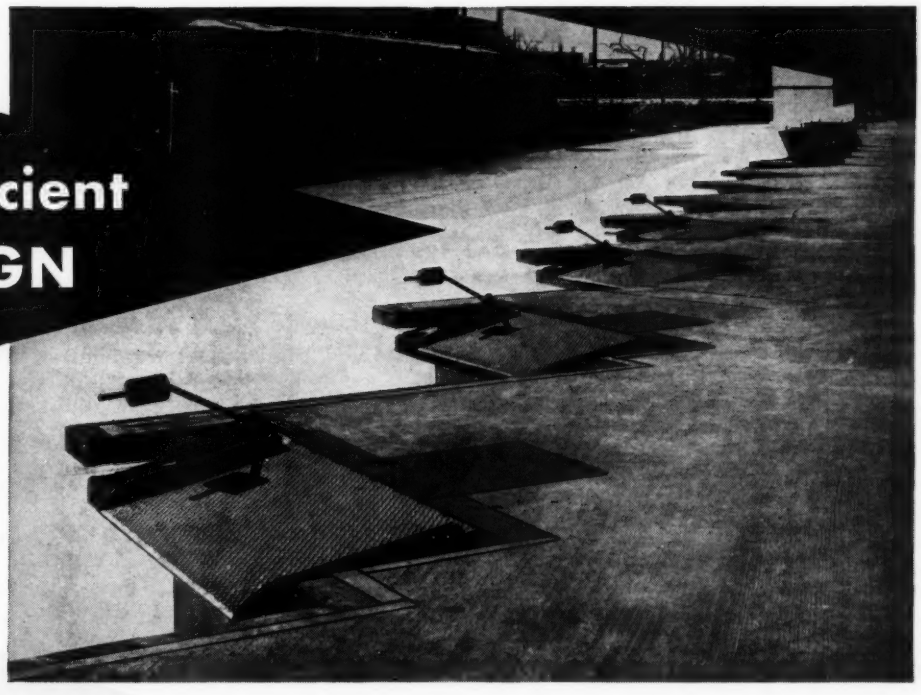
Heat generating elements are sheets of Pyrex brand heat resistant glass with an electrically conductive film fired on to the back surface.

The heating panels are made by the Corning Glass Works, Corning, N. Y.

Units Maintain Humidity In Unheated Buildings

Designed especially for storage warehouses and war production plants placed in stand-by condition, an adaptation of the Kathabar humidity conditioning equipment represents an effective combination of refrigeration and chemical dehumidification. An

For most efficient
DOCK DESIGN



Specify

RITE-HITE® ADJUSTABLE LOADING RAMPS

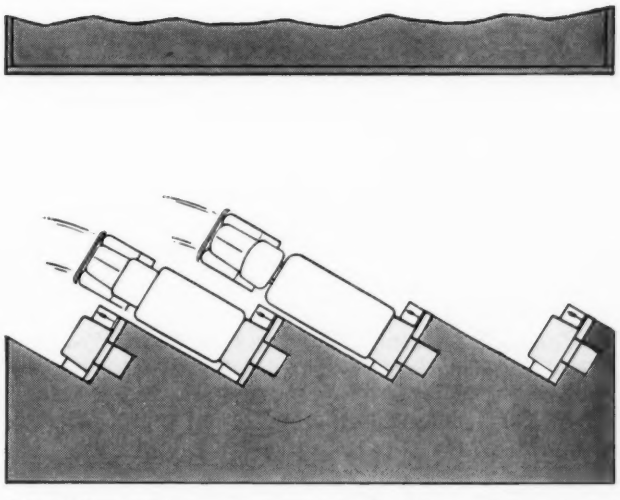
Rite-Hite makes it possible for you to utilize available dock area to best advantage. Rite-Hite insures parking of trucks in an orderly, space-saving manner. Loading and unloading is speeded, efficiency of dock operations is increased, costs are reduced.

A permanent part of the dock, Rite-Hite is maintenance-free, works on a simple but unique counterbalance principle, will give trouble-free service year after year.

Installation in new construction adds practically nothing to the cost of the building. In existing construction, installation costs are modest.

Rite-Hite offers 5 models in capacities of 10,000 and 20,000 pounds. Priced from $395 to $995.

It will pay you to include Rite-Hite Adjustable Loading Ramps in your planning.



Rite-Hite Loading Ramps installed in a dock at an acute angle to provide safe, efficient material handling in a limited area.

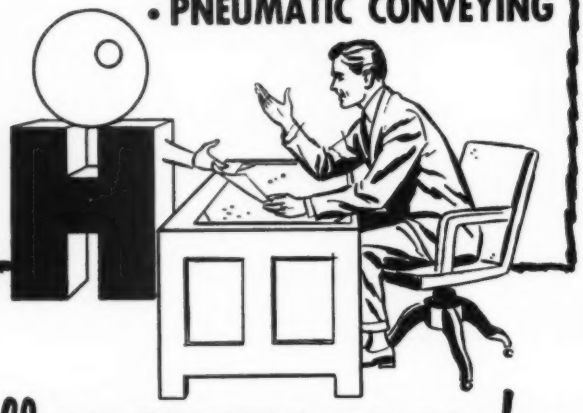
RITE-HITE® DIVISION
LOOMIS MACHINE COMPANY
FOURTH AND PINE STS., CLARE, MICHIGAN

Send for this EIGHT-PAGE BULLETIN, TODAY. Dept. CE-14

When the project involves:

• DUST REMOVAL

• PNEUMATIC CONVEYING



Call HOFFMAN for

• HEAVY-DUTY VACUUM EQUIPMENT

• SPECIALIZED ENGINEERING ASSISTANCE

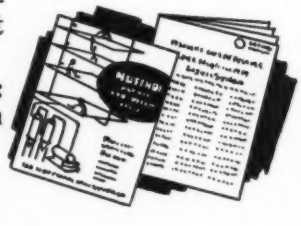
Hoffman Vacuum Cleaning Equipment removes dust rapidly and thoroughly at a cost far below other cleaning methods. The equipment can be easily installed in new or existing buildings—can supplement low pressure collecting systems to remove *all* plant dust—can be adapted to pneumatic conveying of granular material.

The application of vacuum equipment to dust removal and conveying problems requires careful consideration of the type and quantity of dust, the rate and distance of conveying, the degree of dust separation, dust hazards and other problems peculiar to each plant.

Hoffman Air Appliance engineers, with years of experience in this field, are available for specialized assistance. They are prepared to furnish reliable data based on thousands of installations in virtually every type of industrial plant.

CALL HOFFMAN, for collaboration on your next dust removal project.

Write for free treatise: "Design Factors in Vacuum Cleaning."



Hoffman also builds centrifugal blowers and exhausters for every industrial use.

AIR APPLIANCE DIVISION

Hoffman

U. S. HOFFMAN MACHINERY CORP., Dept. CE, 105 FOURTH AVE., NEW YORK 3, N. Y.

Units Maintain Humidity

—*Starts on page 56*

air-cooled compressor is used with the condensing coil located in the leaving air stream, giving the system adiabatic operation.

The units do not require heating of the building in order to maintain 35 percent relative humidity, even to as low as 20 F.

Low maintenance cost, extreme reliability, and no carryover of absorbent are some of the advantages claimed for these units. Because they employ a liquid dehumidifying agent, it is possible to handle more air for the same or less investment.

Near Record Construction Predicted for 1954

One of the world's largest engineer-architect firms sees for 1954 almost record industrial and public works construction and believes the year will bring the continuation of a program of replacement of existing plants and distributing facilities as industry strives hard for improved manufacturing and selling economies.

The company, Giffels and Vallet, Inc., L. Rossetti, which has had a major part in the last eight years in the designing and engineering of the huge atomic works at Hanford, Washington, and Paducah, Oak Ridge and Portsmouth, winds up 1953 with one-third of a current atomic assignment involving an outlay of about $1½ billion still to be completed. But on top of this huge government assignment, 1953 was a record year for assignments in behalf of industrial corporations, and indications are that the first half of 1954 will equal the 1953 rate, with the last half of the year offering promise of volume almost at the 1953 rate. Volume of the firm is considered a barometer which forecasts nation-wide industrial activity.

Increase in Research Activity

Although industrial emphasis in 1954 will be on improved manufacturing facilities to lessen the pressure between cost of goods sold and selling prices, according to Victor E. Vallet, president, an extremely interesting development is the extraordinary number of research and scientific laboratories now in process of engineering and design for some of the most aggressive companies in this nation and Canada. Since the lead-time of a research project averages between four and ten years, depending upon the industry involved, it is believed that unprecedented research activity is in store for the nation. The accelerated research should mean, as it always has, a steadily growing work force and national economy.

One of the industries right "up against the gun" to reduce costs in manufactured products is the foundry industry. Foundry technology is advancing rapidly. Even many foundries put into operation

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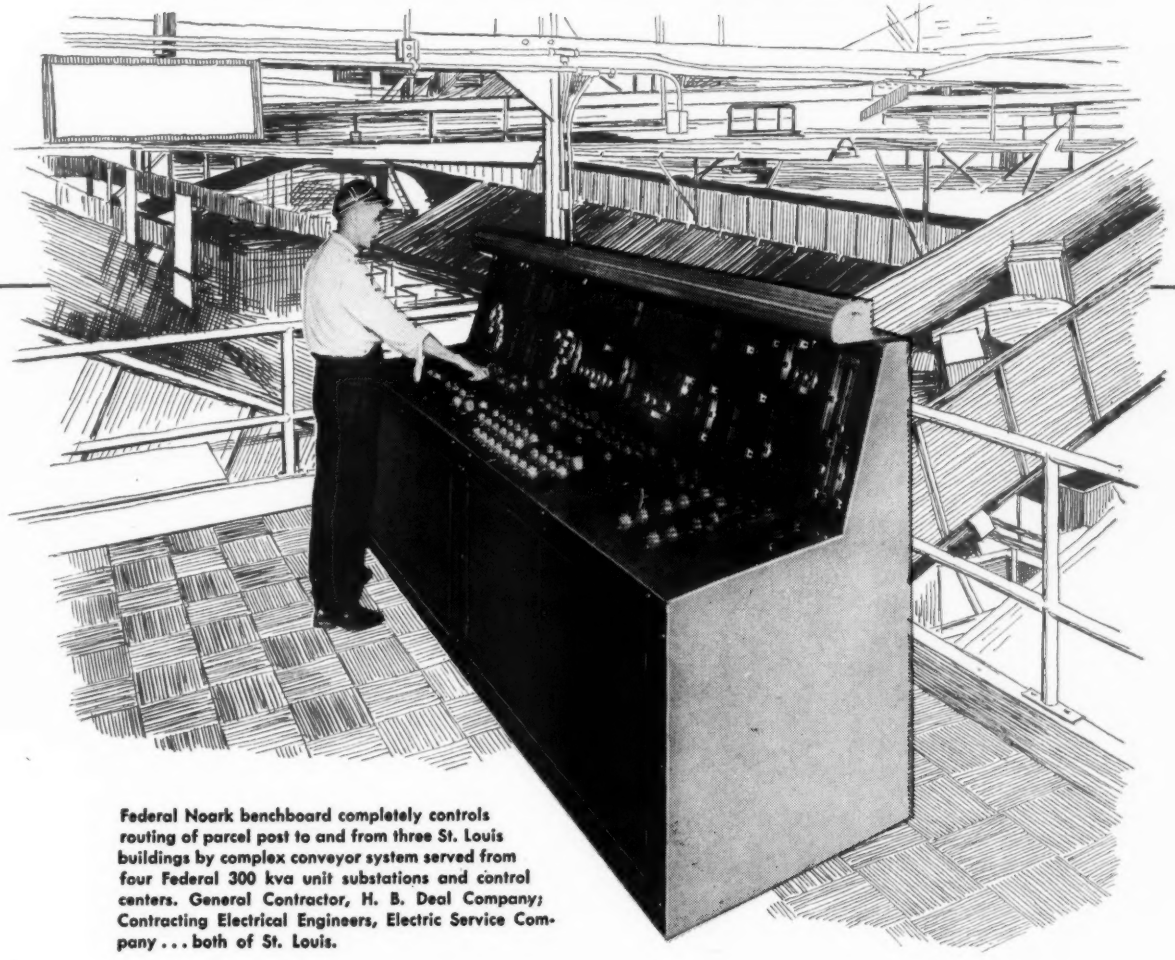
HELPS SPEED ST. LOUIS MAIL



Federal Noark benchboard completely controls routing of parcel post to and from three St. Louis buildings by complex conveyor system served from four Federal 300 kva unit substations and control centers. General Contractor, H. B. Deal Company; Contracting Electrical Engineers, Electric Service Company . . . both of St. Louis.

PARCEL POST in St. Louis is now rapidly moved by the Terminal Railroad Association's new conveyor system from Union Station, a new Terminal building, and the Post Office. This system, the most elaborate of its kind in the country, is powered from four Federal Noark Unit Substations and controlled by a specially-designed Federal Noark indicating bench board.

The unit substations are 300 kva, 4180/480 volt, 3-phase. Each has a three-position fused primary selector switch so that either of two primary sources can be selected. Each station has a main secondary breaker feeding a close-coupled control center. Secondaries from all units can be tied together through Federal Noark Bus Duct.

The benchboard completely outlines the entire system and can select any number of conveyor arrangements which are instantly indicated by illuminated routings shown in miniature.

Here is another example of Federal's ability to handle your distribution or control problems. Remember, Federal Noark has the engineering skill and manufacturing facilities to provide exactly the right equipment for your requirements.

Federal Electric Products Company
50 Paris Street, Newark 5, New Jersey

Federal Noark products: Stab-lok Circuit Breakers, Motor Controls, Safety Switches, Service Equipment, Industrial Circuit Breakers, Panelboards, Switchboards, Control Centers, Bus Duct — **Pacific Electric Manufacturing Corporation products:** High voltage circuit breakers and power switches ★ Sales offices in principal cities.

FEDERAL NOARK

Prediction for 1954

—Starts on page 58

within the last few years are falling behind technically and will have to undergo sizeable rehabilitation programs in order to compete product costwise with newer ones already under construction or on the drawing boards.

To more nearly offset increased labor and freight rates with lower production and distribution costs, the large automobile, appliance, radio and television, rubber and plastics, and food processing firms are carrying out carefully planned programs of plant rehabilitation, as well as relocation and building of new plants.

Mr. Vallet went on to say, "Our continuing contacts with the executive officers, and manufacturing and engineering executives of client companies bring to us information on industrial expansion that, while indicating sensible caution in capital commitments, gives no indication whatsoever of any real drop in demand for our type of work and since plant and research laboratory projects mean more jobs, it is hard to visualize any serious downward adjustment in the construction field.

"In the school field, it is common knowledge that virtually every state, city, and town is 'bursting its seams' in taking care of the increased school age population. We see tremendous volume in school design and construction in the next few years with the impetus beginning to be felt in 1954.

"Other public works, done normally and not to bolster the economy, will include hospitals, superhighways, congested area parking facilities, and municipal and county buildings of various types. These, however, mean only construction and material employment, as against the industrial work that means tremendous contributions to the economy."

Dr. P. C. Rutledge Will Speak On Salinity Control Barriers

Speaker at the annual meeting of the American Institute of Consulting Engineers was William Zechendorf, president of Webb and Knapp, Inc.,—his topic: "The Significance and Implications of the Movement of Industry and Trade from New York City to the Suburbs."

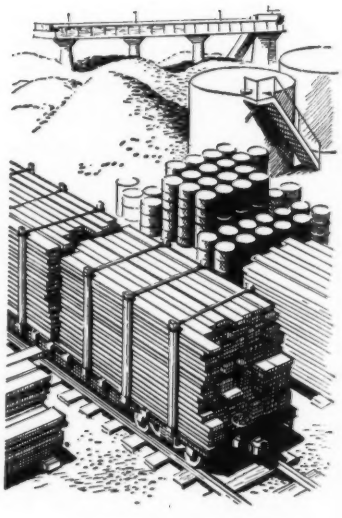
The February 3rd luncheon meeting (the Engineers' Club, 32 West 40th St., New York City) will feature Dr. Philip C. Rutledge, partner, Moran, Proctor, Mueser & Rutledge, speaking on "The Study of Salinity Control Barriers in San Francisco Bay."

Complete data on RAW MATERIALS to help service your clients

—get it *quickly and without cost* from Industrial Location Service of New York State.

When you're looking for a location near raw materials—or to which raw materials can be shipped economically, write to the Industrial Location Service of the State of New York. We'll supply you with comprehensive, up-to-date information on the availability and cost of raw materials at many desirable sites.

To help you prepare recommendations for your clients, we'll also send you data on the quantity, quality, suppliers of raw materials needed—and even the location of undeveloped sources.



AUTHORITATIVE DATA IS AVAILABLE ON:

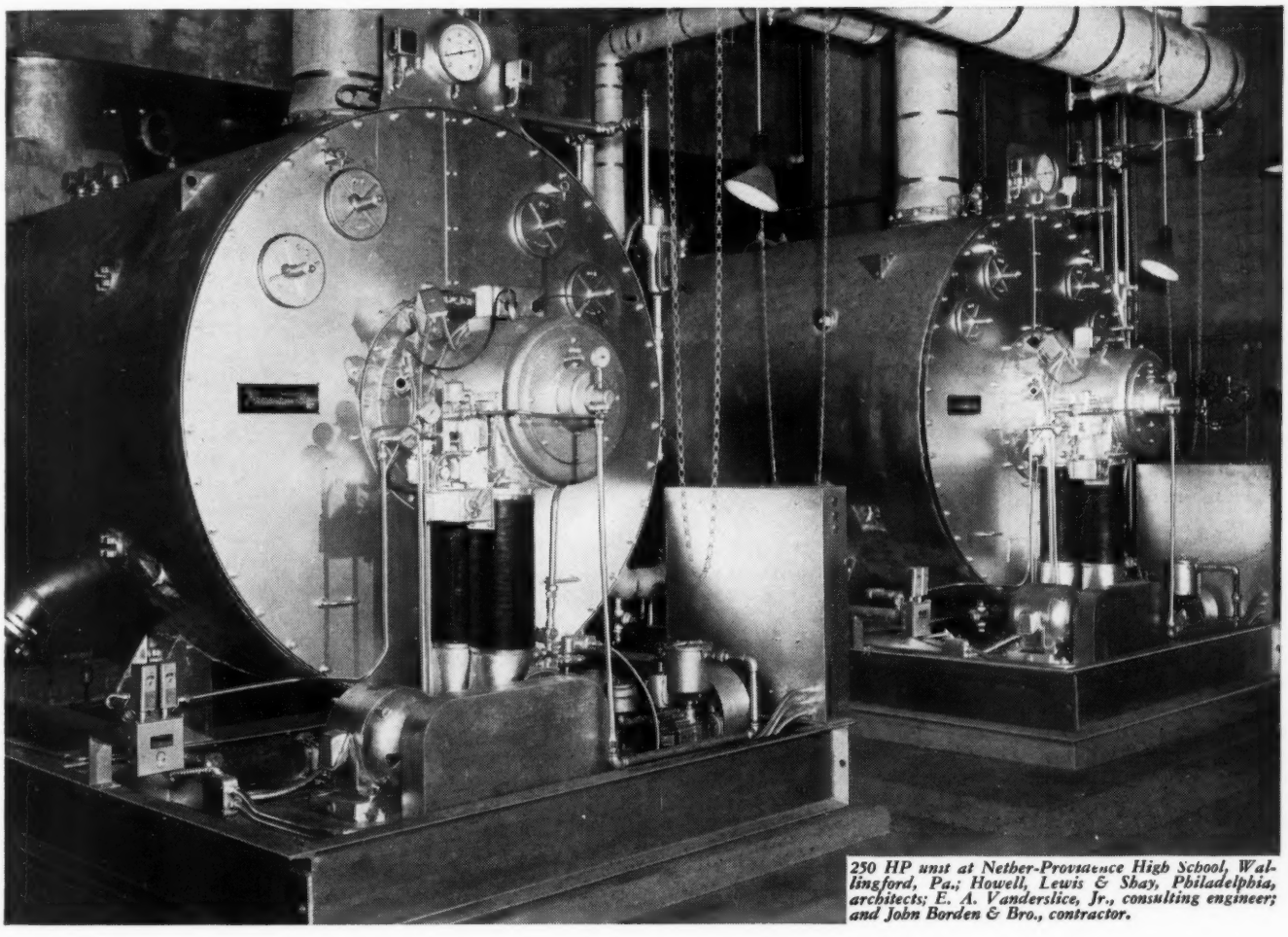
RAW MATERIALS: Cost and availability of all materials and supplies needed.
TRANSPORTATION: Availability of facilities, cost of assembling materials and distributing finished product between any given points.
MARKETS: Industrial and consumer market data.
LABOR: Availability, skills, and rates.
POWER AND FUEL: Character and cost at any point.
AVAILABLE BUILDINGS: Types, condition, facilities and terms. Confidential.
SITES: Availability, size, character, installed services; photos and maps. Confidential.
COMMUNITY SERVICES: A complete report on the facilities and attitudes of any community.
LAWS AND REGULATIONS: Full data on laws or regulations applying to any particular form of enterprise.

Industrial Location Service of New York State

GET FREE BROCHURE: "Industrial Location Services." Also detailed physical map of New York State. Write New York State Department of Commerce, Room 832, 112 State St., Albany 7, New York.

"WE DON'T SELL SITES—WE MATCH NEEDS"

at SCHOOLS and COLLEGES



250 HP unit at Nether-Providence High School, Wallingford, Pa.; Howell, Lewis & Shay, Philadelphia, architects; E. A. Vanderslice, Jr., consulting engineer; and John Borden & Bro., contractor.

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ALL OVER AMERICA, steam and hot water requirements for public and parochial schools, private schools, trade schools, and colleges are being supplied by *Powermaster* Packaged Automatic Boilers . . . with an outstanding record of reliability and economy. Why have they been so widely "accepted" in educational circles by men who can evaluate the aptitude of boilers for this particular kind of service? Because by all standards of comparison, *Powermasters* possess these qualifications for "enrollment" in any kind of school: Ease and economy of installation—space-saving compactness—fuel-saving smokeless combustion—fuel-saving operation at *all* loads—maintenance-saving accessibility—completely automatic operating and safety controls—minimum attention of service personnel.

Compare *Powermaster* with any other packaged boiler and you'll understand why it is today's best buy for institutions of learning . . . or buildings . . . or hospitals . . . or industrial plants. Send for latest descriptive bulletin.

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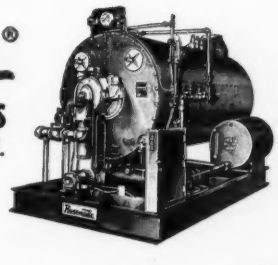
PACKAGED AUTOMATIC BOILERS
In sizes to 500 HP; pressures to 250 psi.



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. . . a careful condensation of available information concerning new products.

Don't THINK

While mathematical problems get longer and harder, computers seem to be getting smaller and smaller. Last month saw two new computers put on the market, both of relatively small size, one described as the "first desk-top electronic analog computer." The larger one is a digital computer, and it occupies three, six foot high cabinets, but you still plug it into any 110-v wall socket.

In case you don't know an analog computer from a digital computer, or for that matter, from a hole in the ground, a little explanation may be in order. Analog computers are used in the study of dynamic systems—interior and exterior ballistic calculations, mechanism design, structural vibration. The new desk top machine *(Reeves Instrument Corp.)* can solve differential equations or simulate physical systems up to the sixth order of magnitude.

Digital computers, on the other hand, are more versatile than analog computers, but they operate at much slower speeds. They are used primarily for the solution of boundary value problems of partial differential equations or for solution of systems of simultaneous algebraic equations. The manufacturer *(Logistics Research, Inc.)* of the new digital computer recommends it for repetitive engineering calculations, preparation of handbook data, correcting test data to standard conditions and for automatic reading, recording, and reduction of test data. The price of this machine is $48,000, which means that unless you got a lot of problems it would be cheaper to hire ten mathematics professors.

The Armour Research Foundation has a more logical suggestion for engineers with relatively few problems (mathematical problems, that is). They have analog computers, digital computers, and four or five other electronic mathematicians waiting to do anyone's equations at the drop of a name on a check. Just take your unsolved boundary value problems of partial differential equations around to 3201 South Michigan Ave., Chicago. They love that sort of thing.

Incidentally, Armour Research Foundation is an independent, not-for-profit organization, so the price should be right. Of course, if you are like some people we know and have a lot of problems, maybe you better buy your own. Personally, we are going to wait until the electronic brain gets down to the size of the hearing aid (with invisible head attachment).

Of perhaps more immediate interest to us is yet another new electronic machine, developed by Battelle Institute, which will scan up to five million published documents per hour and identify them with relation to the information needed. President Clyde Williams says, "Although able to perform routine information hunting with high speed, excellent precision, and unwavering patience, the machine will, in fact, be a moronic robot".

Here's proof!

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JOHNSTON	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
PUMP "A"	EXTRA CHARGE			YES	YES	YES		EXTRA CHARGE	YES	YES	
PUMP "B"				PART OF IMPELLER	YES	YES			YES	YES	
PUMP "C"	EXTRA CHARGE	EXTRA CHARGE		YES	YES	YES	YES	EXTRA CHARGE	EXTRA CHARGE	EXTRA CHARGE	YES
PUMP "D"	EXTRA CHARGE	REPAIRS ONLY				YES		EXTRA CHARGE	YES	YES	
PUMP "E"	EXTRA CHARGE	SHD SEAL YES	YES	YES	YES	YES	YES	YES	YES	YES	
PUMP "F"	EXTRA CHARGE	EXTRA CHARGE		YES	YES		YES	EXTRA CHARGE	EXTRA CHARGE	EXTRA CHARGE	
PUMP "G"				SO-CALLED SEAL	YES	YES		YES	YES		
PUMP "H"		CERTAIN SIZES ONLY			YES	YES			YES	1 PINT	
PUMP "I"						YES			YES	1 PINT MANUAL	
PUMP "J"	EXTRA CHARGE			YES	YES	YES	YES		YES	YES	

NOTE: This information taken from available price book and printed literature.

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IS PRE-PROVED BY TESTING

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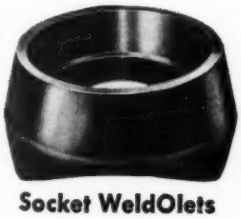
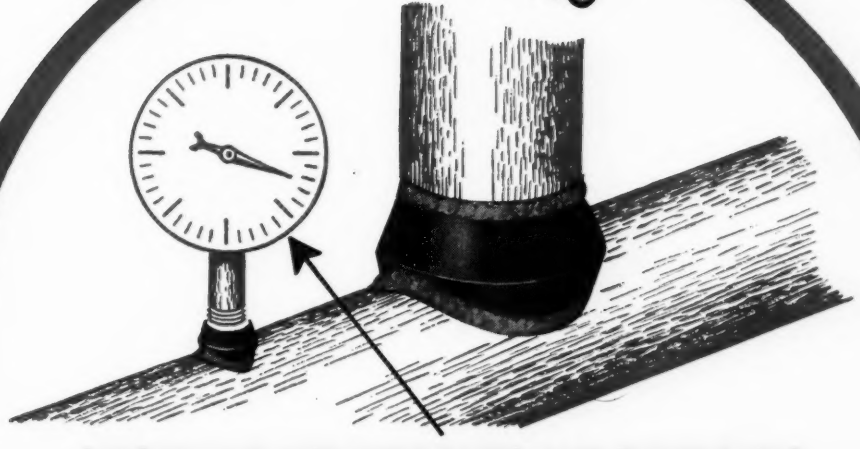
Butt-welding



Socket WeldOlets

ThredOlets



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Their predetermined performance standards are your guarantee of permanent piping. WeldOlet and ThredOlet design and performance are backed by Bursting Tests in accordance with A.S.A. B16.9 Code for Welding Fittings.

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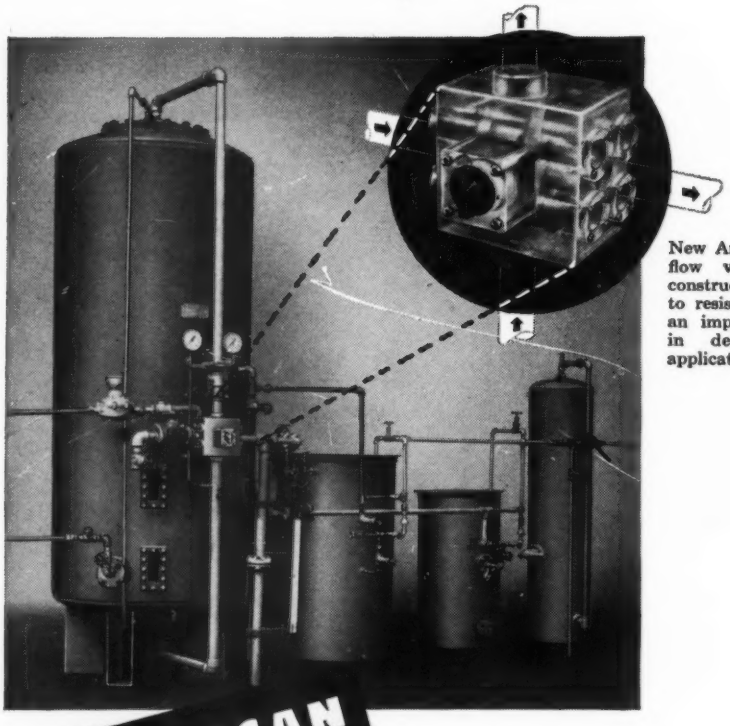

New American Cycloflow valve, entirely constructed of plastic to resist corrosion . . an important feature in demineralization applications.

AMERICAN DEMINERALIZATION

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Where the equivalent of distilled water is required in the processing and chemical industries, American Demineralizers are providing large quantities economically and continuously.

Textile, chemical, petroleum, pharmaceutical and rubber industries have replaced distillation equipment with American Demineralizers at appreciable savings in operating cost. In power plants, American Demineralizers are used extensively for the treatment of boiler feedwater, particularly for high pressure boilers.

This process first removes the cations and converts the anions to their corresponding acids which are then removed.

This and many other American processes are the products of American leadership in water conditioning for over half a century. Contact our engineers today for the answer to your water problems.

*Demineralization does not remove bacteriological contamination.

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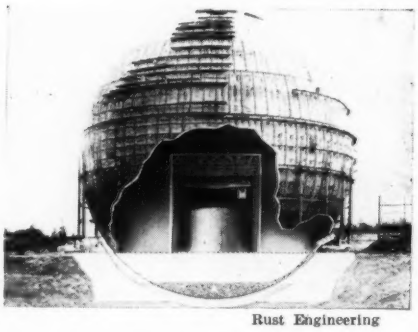
Sphere Will House Atomic Submarine Project



Rust Engineering

Like an egg in an egg cup, this 225-ft sphere, which will house an atomic submarine reactor, is designed to rest on a foundation some 38 ft below ground level.

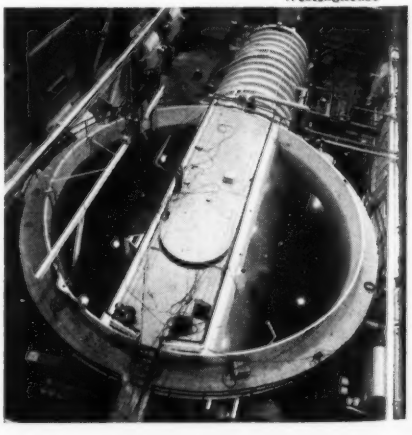
The problem faced by the Rust Engineering Co., was to pour a 3900 cu ft cushion of concrete beneath the hollow ball, and 28,000 tons of limestone fill inside it without setting up localized stresses that might break its one-inch skin or distort its shape.

To accomplish this Rust placed crushed limestone inside, and poured concrete outside the sphere on alternate days in three-foot layers.

Called SIR Mark A, this project is the landbased prototype part of the SIR Project for the Navy's "Sea Wolf." It is under the direction of the Knolls Atomic Power Laboratory of Schenectady, N. Y., which is operated for the Atomic Energy Commission by General Electric Co.

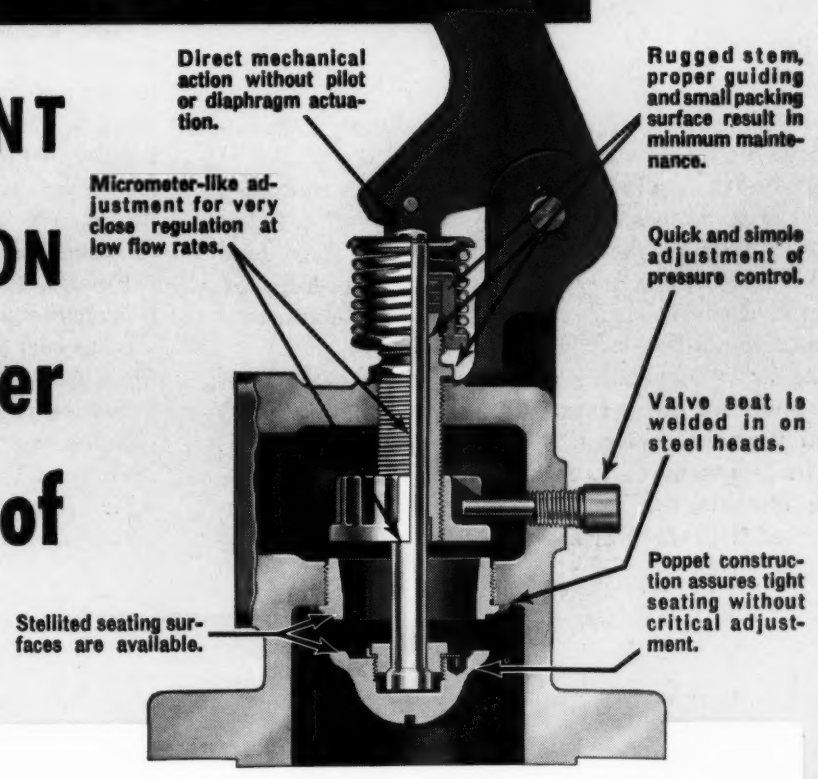
The SIR represents one of two approaches being taken in the problem of driving submarines by atomic energy. The picture below shows the other reactor, STR, the landbased prototype of the nuclear power plant in the Navy's first atomic submarine, "Nautilus" launched by the Electric Boat Division of General Dynamics Corp., on January 21, 1954.

Westinghouse



POPPET TYPE VALVES

An IMPORTANT REASON for the better performance of *these* DIAMOND Blowers

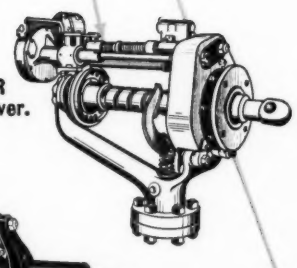

Direct mechanical action without pilot or diaphragm actuation.
Rugged stem, proper guiding and small packing surface result in minimum maintenance.
Micrometer-like adjustment for very close regulation at low flow rates.
Quick and simple adjustment of pressure control.
Valve seat is welded in on steel heads.
Poppet construction assures tight seating without critical adjustment.
Stellited seating surfaces are available.

Note carefully the important advantages pointed out on the illustration above. You will see why Diamond Poppet Type has proved its superiority by many years of successful operation on the most difficult jobs.

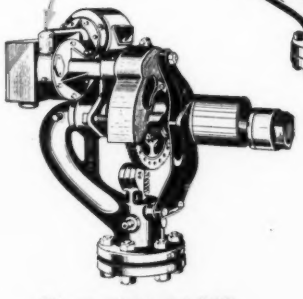
The integral adjustable pressure control device is used when boiler or header pressure is higher than desirable for blowing. Its location outside the path of valve travel permits full and immediate opening of the poppet valve, thus avoiding wire drawing.

The valve readily lends itself to examination and repair. Disc and seat are quickly accessible, and regrinding can be done quickly without dismounting the head. Seat and disc are forged and the stem rolled from stainless steel.

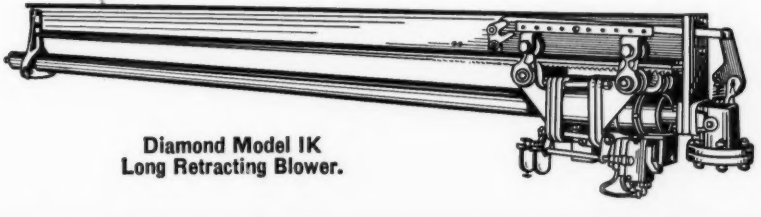
This valve construction is one of the many reasons why Diamond Blowers give better boiler cleaning at lower cost.



Diamond Model IR
Short Retracting Blower.



Diamond Model G9B
Automatic Valved Blower.



Diamond Model IK
Long Retracting Blower.

50th ANNIVERSARY 1903-1953

DIAMOND POWER SPECIALTY CORP.
LANCASTER, OHIO
Diamond Specialty Limited, Windsor, Ontario

6258

Unions

—Starts on page 23

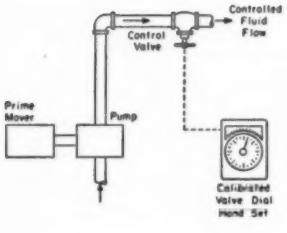
Taft-Hartly Act which exempts engineers from enforced union membership.

The next step is to persuade employers that they are in real danger of becoming saddled with a union more difficult to handle than any they may now have. To forestall this, they must truly recognize the worth of engineers in their organization—both economically and as individuals.

Another important point is to insure that college students are not permitted to become indoctrinated with the union concept. This is not to say that E. S. A. or its counterpart should be prohibited from contacting students, but rather that students must be impressed with the philosophy of engineering as a profession and allowed their freedom of choice. With college faculties underpaid by industry standards, additional vigilance may be required in some areas to make certain that this is done.

Also, the national societies must bring to early fruition their efforts to unite in a manner calculated to serve the need of a profession and, at the same time, to preserve the identity of the groups providing the membership. Unity will dispel doubts which now exist and will provide the means for engineers to improve their economic status without resorting to collective bargaining.

Finally, every engineer who would be known as a professional man must be willing to offer his service to carry out these measures. This means more than mere lip service. We must exert our personal influence at every opportunity to combat a growing menace—even create the opportunity to do so if necessary. For once, all engineers have a challenge which cannot be ignored if they wish to continue as members of a profession.



Principles Of Feedback

—Starts on page 45

paths are readily included if simultaneous control by several variables is required.)

If the above ratio control constitutes only a single phase of a complex process, eventually leading to the manufacture of a chemical product for example, a more direct feedback may take place from the final product itself. Continuous measurements on the product and the interpretation of these measurements by a computing machine may lead to adjustment of control factors at all contributory phases in the over-all process; thus, final quality can be controlled. Such a system would be self-correcting, continually re-adapting itself to "environmental" changes, with optimization of quality as the justification for its existence.

In the case of the variable-speed pump control, it would be much more direct to feed back a signal proportional to pump pressure head, rather than to allow that variable to be indirectly controlled by changing pump speed. In general, for maximum benefit, the feedback signal should be taken off as close to the final desired result as possible.

In closed-loop systems, the only basic source of error other than inaccuracy in the measurement and comparison elements, is due to the finite gain of the amplifier. In following a variable input order, the source of control power is the amplified error (Fig. 7). Therefore, the higher the gain, the lower need the error be; but unfortunately, gain cannot be increased indefinitely without introducing system oscillations, or hunting.

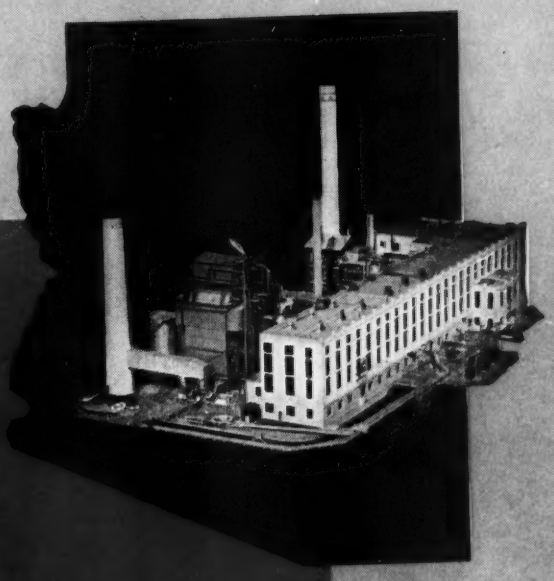
When hunting occurs, the controlled quantity swings about its equilibrium position either continuously or for a long time before coming to rest. Oscillations may be controlled by introducing dissipation in the system, just as the oscillations of a spring and inertial mass are damped out through the addition of friction.

Damping Techniques

Another technique for oscillation damping is based upon applying to the amplifiers not the actual system error, but anticipated system error, thereby applying corrective action somewhat earlier. Anticipated error is determined from the measured error's rate of change. Dynamically speaking, this technique for damping is equivalent to the inclusion of dissipation as mentioned.

Feedback control was originally limited to the problem of simple remote positioning. Today, many process industries are set up with completely automatic feedback systems. With the increasing range of temperatures, pressures, and speeds, which characterize industry, the gradually increasing role of feedback control is natural and inevitable. By "watching over" the final variable and forcing the system to follow input instructions, the feedback system behaves as a faithful, tireless servant, whose utility is limited only by the ingenuity of its design.

ALSO IN ARIZONA, IT'S YARWAY



PUBLIC SERVICE

PICKS

YARWAY UNIT TANDEMS

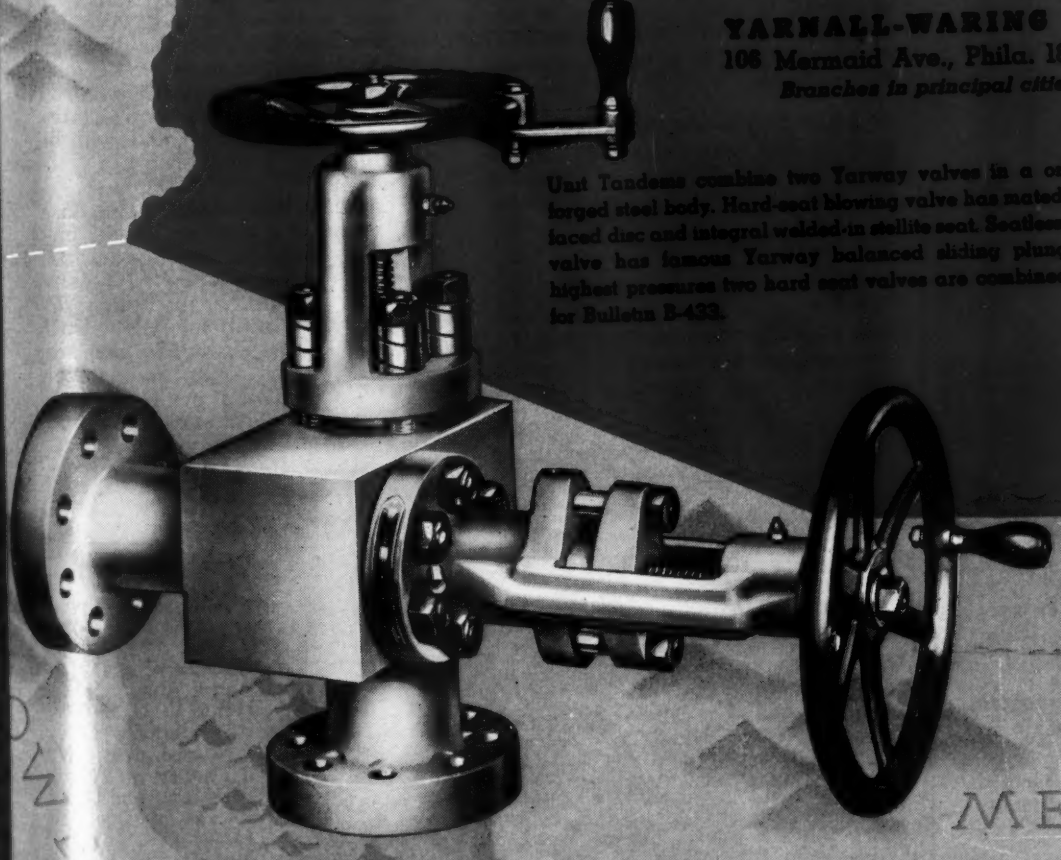
FOR 920 PSI BLOW-DOWN SERVICE

Arizona Public Service Company—operating in the youngest, but one of our fastest-growing states—is another prominent utility that relies on Yarway Unit Tandem Blow-Off Valves to guard its boilers. In fact, *4 out of every 5 high pressure boiler plants are Yarway-equipped.*

Such popularity had to be won. It was—by offering good design, careful engineering and manufacturing, modern metallurgy and dependable service.

Yarway engineers, conveniently located near you, are constantly working for better, more profitable steam plant operation. Need help? Call a Yarway man.

YARNALL-WARING CO.
106 Mermaid Ave., Phila. 18, Pa.
Branches in principal cities



Unit Tandems combine two Yarway valves in a one-piece forged steel body. Hard-seat blowing valve has mated stellite-faced disc and integral welded-in stellite seat. Seatless sealing valve has famous Yarway balanced sliding plunger. For highest pressures two hard seat valves are combined. Write for Bulletin B-433.

YARWAY SERVICE GOES ALL THE WAY....

There's Certain satisfaction in **PRODUCTS BY**

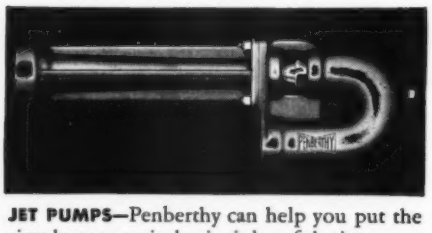
PENBERTHY

Automatic Electric SUMP PUMPS

Corrosion resistant Penberthy sump pumps, copper and bronze throughout, are available in 7 sizes, 3 models. Now, the *new submersible* sump pump offers additional superior features worth investigating.

LIQUID LEVEL GAGES

Penberthy makes a complete line of gages and valves. 70 years of engineering experience is on hand to accomodate your particular requirements. You are assured complete cooperation and reliable product service for any pressure... in any length.



JET PUMPS—Penberthy can help you put the simple, economical principles of the jet pump to work wherever it's necessary to transfer or mix any liquid which will flow through a pipe. We make a complete line.

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...are among the other products by Penberthy. Write for literature detailing specifications and advantages.

PENBERTHY INJECTOR COMPANY

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Manufacturers of Quality Products Since 1886

MEN IN ENGINEERING

★ Paul Diserens, consulting engineer, and until 1952 director of research and development of the Worthington Corporation, was honored at a testimonial luncheon upon the occasion of his retirement in the 45th year of his service to the company. In addition to his work with Worthington, Diserens was responsible for numerous developments in connection with high pressure compressors for the United States Navy.

★ The Lummus Company has appointed the industrial division of the Sterling Advertising Agency, Inc., to handle its advertising and public relations, effective January 1, 1954, according to Robert Hennes, advertising manager of the company. Paul B. Slawter, Jr., is to be the account executive.

★ John J. O'Brien, formerly manager of the manufacturing department for the Milwaukee Hotpoint Division plant, is appointed manager of the industrial engineering department, The Trane Company.

★ The American Institute of Chemical Engineers has elected as president for 1954, Chalmer G. Kirkbride, president and director, Houdry Process Corp. Barnett F. Dodge, head of the chemical engineering department at Yale University, is vice president; George Granger Brown, dean of the University of Michigan, is treasurer; and Stephen L. Styler is re-elected secretary. New directors are: Loren P. Scoville, Ray P. Dinsmore, George E. Holbrook, and W. L. Faith.

★ O'Brien & Gere, consulting engineers, recently announced the appointment of Samuel J. Grosso, Frank A. Loguidice, and Joseph I. Phillips as associate members of the firm.

★ Westinghouse Electric Corp. has engaged the services of the New York engineering firm of Sanderson & Porter to consult with its Aviation Gas Turbine Div., on the development and production of jet engines. P. B. Taylor, a partner of Sanderson & Porter, will direct the firm's activity with Westinghouse and will be assisted by S. T. Robinson.

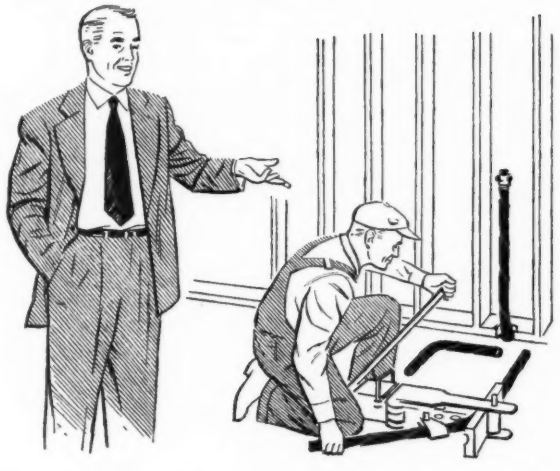
★ The Fluor Corporation, Ltd., has been awarded a contract for the engineering, material procurement, and construction of a new allyl chloride and chlorohydrins plant at Norco, Louisiana for the Shell Chemical Corp. R. K. Walters, recently appointed a senior engineer in Shell Chemical's head office, is construction superintendent. He will be assisted by E. P. Franzen, project

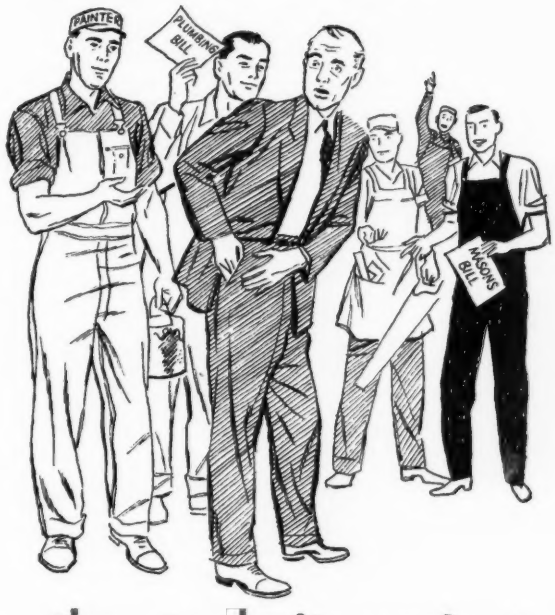
NEW ASSOCIATION

Officers of the newly organized Consulting Engineers Association of Oklahoma are, left to right: W. H. Stueve of Oklahoma City, vice president; W. C. Roads of Tulsa, president; and C. C. Pate of Tulsa, secretary-treasurer. Membership of the new group is limited to engineers in private consulting and professional practice. Headquarters will be in Tulsa.

The LONGER LIFE of WROUGHT IRON PIPE

proves...





It costs less to do it right | **—than to do it over!**

When you specify pipe there are two things well worth remembering—

1. When you install it, you pay only the pipe fitter,

but

2. Every time you repair it, you pay pipe fitter, carpenter, mason, plasterer, and painter.

This dollars-and-cents difference underscores the fallacy that low-first-cost materials are the answer to piping economy. And these same facts provide a yardstick that places the economy emphasis where it rightly belongs . . . on PIPE SERVICE LIFE. The longer service life of wrought iron pipe has proved to thousands of users that it costs less to do it right than to do it over. In installation after installation, wrought iron pipe has doubled, tripled, and even quadrupled the useful life previously obtained from low-first-cost piping. These users have discovered that although you pay a little more for wrought iron, you pay a LOT LESS FOR MAINTENANCE. Wrought iron gives you piping economy because it lasts longer, at lower cost per year.

We'll welcome the opportunity to discuss your particular corrosion problems, and to show you wrought iron durability records in services similar to those in which you are interested. Write or call. Your request will be handled promptly.

A. M. Byers Company, Pittsburgh, Pa. Established 1864. Boston, New York, Philadelphia, Washington, Atlanta, Chicago, St. Louis, Houston, San Francisco. Export Department: New York, N. Y.

Why Genuine Wrought Iron Lasts

This notch-fracture test specimen illustrates the unique fibrous structure of wrought iron—which is responsible for the high corrosion resistance of the material. Tiny threads of glasslike silicate slag, distributed through the body of high-purity iron, halt and disperse corrosive attack, and discourage pitting and penetration. They also anchor the initial protective scale, which shields the underlying metal.

BYERS

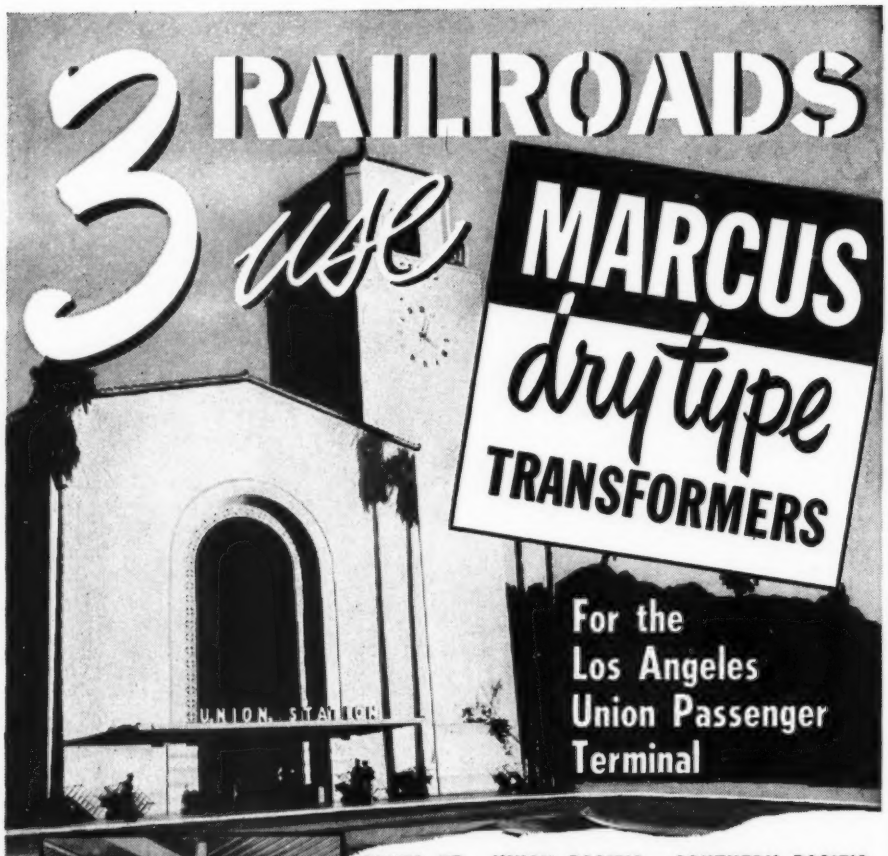
CORROSION COSTS YOU MORE THAN WROUGHT IRON

WROUGHT IRON

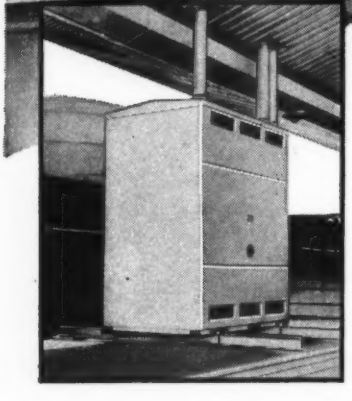
TUBULAR AND HOT ROLLED PRODUCTS

ELECTRIC FURNACE QUALITY ALLOY AND STAINLESS STEEL PRODUCTS

3 RAILROADS use MARCUS dry type TRANSFORMERS



For the Los Angeles Union Passenger Terminal



SANTA FE RAILWAY | UNION PACIFIC RAILROAD | SOUTHERN PACIFIC COMPANY

Specifications for the stringent power requirements for Los Angeles Union Passenger Terminal were set up by a group of electrical engineers representing the three railroads that operate the terminal, and were met by the purchase of Marcus dry type Transformers.

The installation consisted of 12 Marcus 300 KVA, 3 Marcus 225 KVA dry type Transformers installed outdoors. All Marcus dry type Transformers are now being constructed with Hi-Heat, Hi-Dielectric Magnet Wire, insulated with DuPont's Newest miracle polyester film "Mylar," combined with Johns-Manville "Quinterra" to reach insulation levels at least 10 times present industry standards.

Increase your power performance standards with Marcus dry type Transformers.

Capacities from 1 to 3000 KVA

- DISTRIBUTION
- GENERAL PURPOSE
- UNIT SUBSTATION
- PHASE CHANGING
- ELECTRIC FURNACE
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- MOTOR STARTING
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MARCUS MTC

"Mark of Quality"

Representatives in Principal Cities

MARCUS
TRANSFORMER CO., INC.
HILLSIDE 5, NEW JERSEY

ONE OF THE WORLD'S LARGEST MANUFACTURERS OF DRY TYPE TRANSFORMERS EXCLUSIVELY

MEN

—*Starts on page 68*

engineer, process; and K. O. McDonald, project engineer, off-site. W. A. Gabig will assist the project engineer, process; and E. A. Lawyer will assist the project engineer, off-site. C. C. Brothers is assistant to the construction superintendent.

★ The American Institute of Architects, St. Louis Chapter, has awarded their Silver Merit Medal to Albert Kahn, Associated Architects and Engineers. The winning entry was the St. Louis Assembly Plant for the Ford Motor Company's Lincoln-Mercury Division.

★ John Findley Peters, an electrical engineer who never went to high school or college, but achieved a distinguished career, has been awarded the Edison Medal, one of engineering's top honors. A Westinghouse consulting engineer, he is a Fellow and Life Member of the American Institute of Electrical Engineers.

PETERS

LEVONIAN

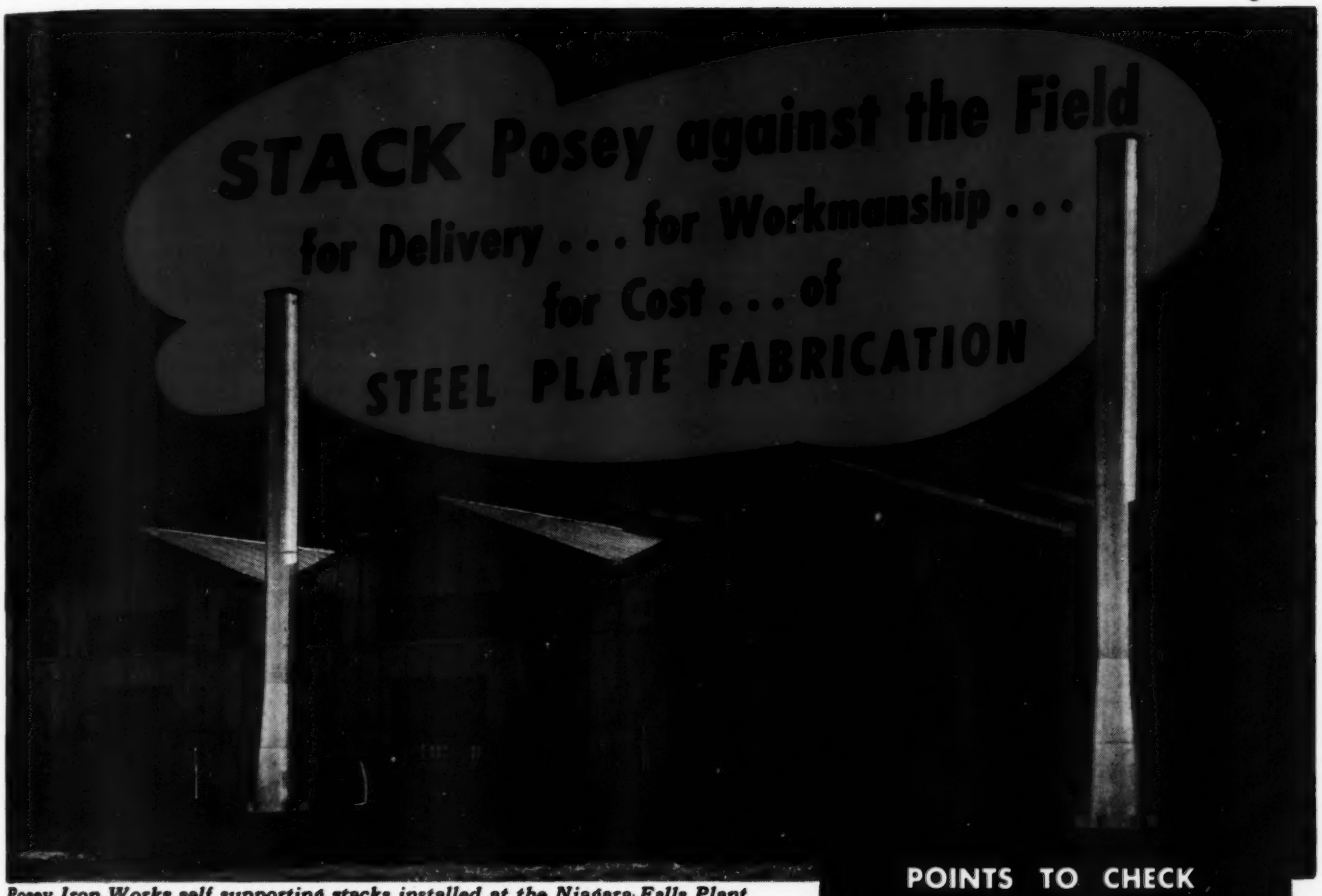
★ H. H. Levonian has assumed new duties as vice president in charge of construction for The Kuljian Corp. At present he is supervising completion of the Bokaro Steam Power Plant in India (CE, March, '53).

★ L. P. Schaefer, head of the engineering department, is appointed secretary of Hinchman Corporation.

★ Robert Nightingale, former chief engineer of the Colson Corporation, joins Wheeler Associates, Inc., as director of the engineering staff.

★ The foundry of the Spartanburg, S. C. plant of the Draper Corporation has recently been completely mechanized at a cost of $1½ million. National Engineering Company designed the mechanical equipment and conveyors, and Lockwood Greene Engineers, Inc., designed all construction work in conjunction with the change over.

★ R. F. Tomlinson, manager, conveyor department, The Oliver Corp., is elected president of the Conveyor Equipment Manufacturers Association to succeed Harry C. Davis, general manager, Kanawha Manufacturing Co. Jervis C. Webb, president,



Posey Iron Works self supporting stacks installed at the Niagara Falls Plant of the International Graphite & Electrode Division of Speer Carbon Co. Height: 50 ft. Diameter: 3 ft.

Posey Iron is really "stackin' 'em up" for industries large and small. Stack buyers find that stacks by Posey Iron are sound in workmanship . . . competitive in cost . . . and delivered on date of promise.

Whether for stacks . . . tanks . . . pressure vessels . . . pipe . . . or digesters . . . steel plate fabrication by Posey Iron meets all standard codes including ASME; API-ASME; API.

Posey Iron does the complete job . . . design . . . fabrication . . . erection. 16½ acres of plant under roof promote smooth flow of production. Shipping is facilitated by favorable location in a key rail and road center — Lancaster, Pa.

Stack Posey Iron against the field on your next stack job. Our estimate puts you under no obligation.

POINTS TO CHECK BEFORE YOU BUY STEEL PLATE CONSTRUCTION

1. Has supplier adequate plant to produce job without costly fumbling and delays?
2. Will supplier assign to your job designers and executives with experience in your field?
3. Have you checked with business acquaintances as to the supplier's reputation for sound workmanship?

Posey Iron WELCOMES requests for further information.

POSEY IRON WORKS, INC.

Steel Plate Division

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ESTABLISHED SINCE 1910

DIVISIONS
Brick Machinery
Foundry
Industrial Heating
Iroquois
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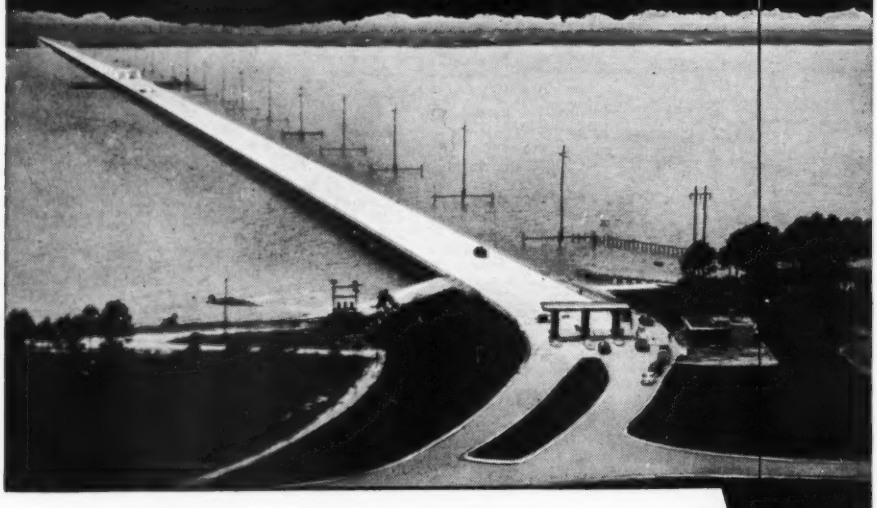
Steel Plate

the new Bay St. Louis Toll Bridge features **TALLER & COOPER** toll collection booths and equipment



To assure the most efficient toll collection, the Mississippi Highway Commission chose Taller & Cooper Booths and equipment for their newest, most modern facility.

The story is the same on major toll facilities throughout the nation. Taller & Cooper prefabricated booths offer safe, efficient, weatherproof toll stations. Taller & Cooper scientific audit collection equipment guarantees the utmost in speed, accuracy and accounting dependability. The combination of the two provides an integrated, efficient system for all types of toll facilities.

To be sure of the best in toll equipment be sure to select TALLER & COOPER.

WRITE TODAY for unique design and construction details.

TOLL BOOTHS • TOLL COLLECTION SYSTEMS

TALLER & COOPER, INC.

ENGINEERS • MANUFACTURERS

58 WASHINGTON STREET • BROOKLYN 1, N. Y.

TALLER & COOPER TOLL COLLECTION EQUIPMENT IS USED ON EVERY MAJOR TOLL FACILITY IN THE U. S.

MEN

—*Starts on page 68*

Jervis B. Webb Co., was elected vice president; E. E. Boberg, sales manager, Standard Conveyor Co., treasurer; Russell B. Maas, president, Screw Conveyor Corp., secretary; and R. C. Sollenberger, executive vice president. Directors are: H. C. Davis, Fred S. Wells, vice president, Stephens-Adamson Manufacturing Co., and D. E. Davidson, vice president for sales, Link-Belt Co.

★ Appointed managing engineer for the industrial engineering department of Walter Kidde Constructors, Inc., is Gerard T. Shannon. Kidde also announced that it has been awarded the contract for engineering and construction of expanded facilities for Durkee Famous Foods Div., of the Glidden Co., Long Island.

SHANNON

BENJAMIN

★ R. N. Benjamin, vice president of Stone & Webster Service Corp., is elected president to succeed George H. Clifford, who was named chairman of the board. William F. Ryan, vice president and engineering manager, is named honorary member of the American Society of Mechanical Engineers.

★ The Austin Company announces several promotions for 1954. Harold A. Anderson is elected vice president and assistant general manager; Allan S. Austin, elected vice president and general sales manager; W. C. Paton, elected secretary; John N. Beckley, named acting eastern district manager. Loren C. Miller succeeds L. H. Burr as works manager of the Structural Steel Fabricating Div. Burr is retiring after 30 years with the company.

★ Dr. Charles J. Kentler, Jr., manager of refinery and chemical sales, Rockwell Manufacturing Co., is named technical consultant for the entire Meter and Valve Division.

★ Since 1950 manager of the Sales & Marketing Department of Ebasco Services, Inc., Paul D. Brooks is elected commercial vice president and member of the board of the American Gas and Electric Service Corp., New York. He succeeds the late Philip Torchio, Jr.

EAST SIDE, WEST SIDE, all around the town . . . 91% of the buildings that make up the fabulous New York skyline are **p-k** equipped. This preference for **p-k** heat exchange equipment — including instantaneous hot water heaters, storage water heaters, pre-heaters, condensate coolers, converters, freon coolers — is understandable because **p-k** fully guarantees its equipment, backs it with 73 years of heat exchange experience.

Contact p-k when your plans get under way.

the **Patterson-Kelley Co.,** inc.

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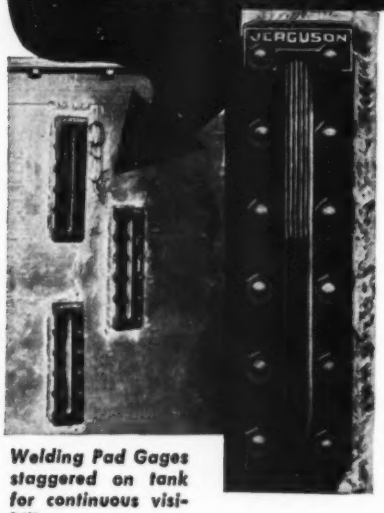
101 Park Avenue, New York 17 • Railway Exchange Building, Chicago 4 • 1700 Walnut Street, Philadelphia 3 • 96-A Huntington Avenue, Boston 16 • and other principal cities.

SPECIAL
JERGUSON
WELDING PAD GAGES
are integral part
of this tank



Welding Pad Gages staggered on tank for continuous visibility.

HERE is a special line of gages that weld right to the liquid containing structure, thus becoming an integral part of it. It solves problems where it is impractical for you to use a conventional type gage because of solids in suspension in a liquid, etc.

These Special Gages follow Jerguson Standard Gages in general design and materials, except for the method of attaching. The chamber of the gage consists of a bar steel pad which is welded to the vessel.

Welding Pad Gages are made in both Reflex and Transparent types . . . in all sizes of Jerguson Standard Gages. Pressure ratings are available to your specific requirements. Welding pad may be of any metal desired to withstand corrosive or other conditions.

Write for Data Unit on Welding Pad Gages for complete details. Whatever your gage problems, let Jerguson engineers assist you.

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Gages and Valves for the Observation of Liquids and Levels

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100 Fellsway, Somerville 45, Mass.
Offices in Major Cities
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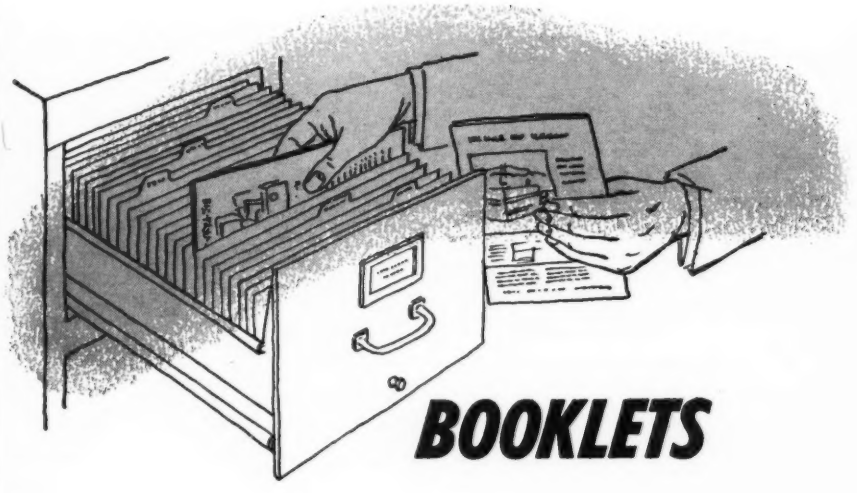
Pétrole Service, Paris, France



BOOKLETS

"YOUR PLANT Could Really Roll in Northeast Ohio," is a comprehensive survey of economic factors favoring location of aluminum rolling facilities in Northeast Ohio. Seven sections cover with facts, figures, and maps, such subjects as "Economics of the Aluminum Market," "Transfer Cost Comparisons," and "Economics of Labor." The appendices give cost and production figures. *The Cleveland Electric Illuminating Co., Dept. CE, 75 Public Sq., Cleveland 1, Ohio.*

FIBERGLAS industrial insulations for use at temperatures from subzero to 1200 F are discussed in 16-page brochure IN6.C2. Photographs, sketches, charts, graphs, and data are included on 17 Fiberglas products for insulation of heated or cooled piping, industrial equipment, ducts, and cold storage rooms. *Owens-Corning Fiberglas Corp., P. O. Box 89, Dept. CE, Santa Clara, Calif.*

CRANES—This seven-page bulletin describes the indoor-outdoor hydraulic crane which is the result of a survey made by this company. Uses of the crane and its special features are illustrated. *Austin-Western Co., Dept. CE, Aurora, Ill.*

NEW AND OLD NEMA dimensions for polyphase squirrel-cage, polyphase wound-rotor, and single-phase, foot-mounted motors are shown on an 18 x 24 in. wall chart as well as separate dimensions for flange-mounted motors. Dimensions for drip-proof and totally-enclosed, fan-cooled motors are also given. *Westinghouse Electric Corp., Dept. CE, 401 Liberty Ave., Box 2278, Pittsburgh, 30, Pa.*

INDUSTRIAL CRANES—Twenty-four-page brochure C6-3 is illustrated with photographs of a wide variety of interesting installations of this company's industrial cranes. Explanatory diagrams and scenes showing different phases of crane production are also included. Complete specifications are listed. *Harnischfeger Corp., Dept. CE, Milwaukee 46, Wis.*

ENGINES—The latest type of engine made by this company for operation on gas, as a diesel, or as a gas-diesel unit is described in 11-page booklet L-71. Complete engineering specifications and ratings are given in graph form along with space plans for diesel and gas-diesel and gas engines. *The Cooper-Bessemer Corp., Dept. CE, Mt. Vernon, O.*

TURBO PUMP—Each component of the type DE turbo pump is pictured and its design advantages explained in a six-page folder. The lubrication system is also described in detail. Typical uses are listed. *The J. S. Coffin, Jr., Co., Dept. CE, 326 S. Dean St., Englewood, N. J.*

PRECIPITATORS—Well illustrated 20-page booklet, 2204B, describes the many applications, principles of operation, design features, advantages, recommendations, flow diagrams, and specifications of the Permutit Precipitator in its three basic designs. Cross-sectional drawings

Personal copies of booklets can be obtained by writing directly to the manufacturers

and cutaway views explain the operation of the unit. *The Permutit Co., Dept. CE, 330 West 42nd St., New York 36, N. Y.*

PRECIPITATION EQUIPMENT—Operators contemplating the installation of equipment for recovering dusts, fly ash, fumes, mists, fogs, or other similar suspensions in stack or process gases will find much valuable data in this 40 page booklet. It summarizes the latest advancements in this company's precipitator equipment, outlines various types of electrode designs, shell constructions, electronic and mechanical rectifier systems, and also gives helpful information on combination mechanical-electrical recovery systems (CMP Units). *Western Precipitation Corp., 1016 W. 9th St., Dept. CE, Los Angeles, Calif.*

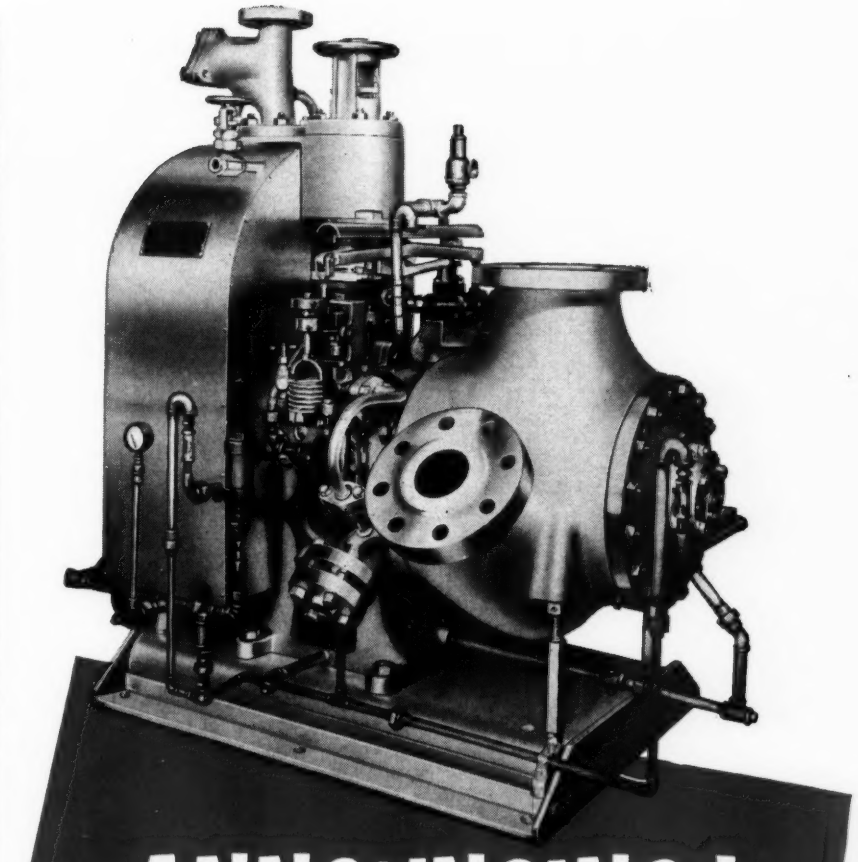
APPLICATION IDEAS, installation tips and suggested circuits for utilizing the Detect-A-Flo unit, a device that controls or detects both liquid level and air flow, are presented in a 16-page illustrated booklet. Also given are detailed specifications, including response curves, on the performance, operation, and electrical characteristics of the unit under various conditions. *Fenwal Inc., Dept. CE, Ashland, Mass.*

"NORTON REFRACTORIES for Heat and Power," 32-page manual 2301 is designed to help in the selection of the proper refractory products for critical areas in boilers for heat and power. It contains detailed information on the characteristics and manufacture of these products, suggested uses, helpful curves on the thermal conductivity and thermal expansion of various refractories. *Norton Co., Refractories Div., Dept. CE, New Bond St., Worcester 6, Mass.*

FACING TILE — Single-unit wall construction with finished facing inside and out is provided by Uni-wall load bearing tile described in 4-page folder UW 100. Shape, construction details, and unit specifications are included. *Natco Corp., 327 Fifth Ave., Dept. CE, Pittsburgh 22, Pa.*

RELATIONSHIPS BETWEEN MATERIAL HANDLING and other functions in an industrial organization such as plant layout, maintenance, personnel, and product design is explained in 12-page booklet 3. General rules for analyzing work-volume and work density are also presented with an example in chart form of work-volume analysis. Price $.50. *Material Handling Institute, Inc., 813 Clark Bldg., Dept. CE, Pittsburgh 22, Pa.*

MANAGEMENT CONTROLS — As a guide to those interested in management controls, this company has



ANNOUNCING !

the **new**

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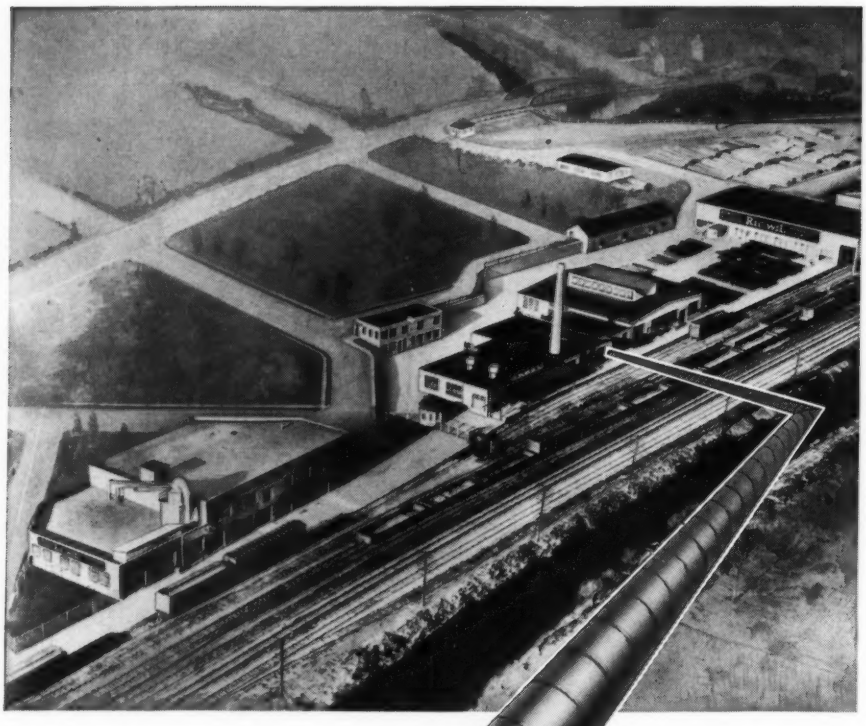

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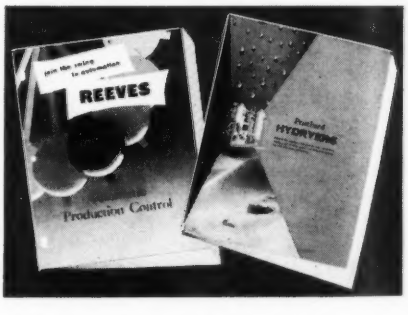
BOOKLETS

—*Starts on page 74*

selected and annotated some of the most valuable books and articles in the field. This 42-page pocket-size booklet is a bibliography covering such subjects as "Basic Materials," "Plans and Policies," and "Tools for Control." *The W. E. Upjohn Institute for Community Research, Dept. CE, 709 S. Westmedge Ave., Kalamazoo, Mich.*

AUTOMATIC CONTROLS—"REEVES Automatic Production Control Booklet," G-537, covers the complete line of automatic controls available on this company's variable speed drives. This 24-page booklet describes means of solving problems involving the control of tension, the control of acceleration and deceleration, velocity and peripheral speed, synchronization of one or more machines and the maintaining of uniform temperature, pressure, liquid level, and flow. Schematic engineering tracings show how these controls can best be utilized to increase production. *Reeves Pulley Co., Dept. CE, Columbus, Ind.*



DEHYDRATION—To meet the increased demand in engineering operations for small volumes of dry gases not warranting plant size installation, this company has developed the Hydryer, described in this seven-page booklet. Operation of the unit is explained by means of text and pictures. Tables give engineering information necessary for ordering. *J. F. Pritchard & Co., Equipment Div., Dept. CE, 210 West 10th St., Kansas City 5, Mo.*

TWO-DRUM, BENT TUBE package boilers for steam, and high pressure, high temperature hot water are discussed in a four-page folder. Ratings, data, and dimensions are given along with cross-sectional drawings. *Springfield Boiler Co., Div. of John W. Hobbs Corp., Dept. CE, 1953 E. Capitol Ave., Springfield, Ill.*

"SYMPOSIUM ON DIESEL Locomotive Engine Maintenance," 145-page manual summarizes the complete

text of a two-day symposium on a diesel locomotive engine maintenance held by this company last spring, and includes 31 individual papers and articles representing the views of 21 participating railroads. It covers such subjects as spectrographic analysis of lubricating oils, filtering and filtering media, cooling water treatment, and railroad applications of the electron microscope. The book has a five-page index in which the entire subject is carefully cross-indexed. *American Locomotive Co., Public Relations Dept. CE, Bldg. 143, Schenectady.*

"POWER at Load Centers Pays Off," 24-page booklet 11B6285B, explains what a load center unit substation is, how they can help improve low voltage caused by heavily loaded feeders, and how they can be placed indoors or outdoors at any convenient location near the load. The selection of proper protective equipment for a specific system is also covered along with information on four types of available transformers—oil filled, sealed dry type, open dry type, and Chlorextol liquid filled. *Allis-Chalmers Mfg. Co., Dept. CE, General Machinery Div., Milwaukee 1, Wis.*

"BASIC PLANNING—Plant Modernization and Expansion," 16 pages outlines a detailed step by step procedure for analyzing existing plant facilities to establish the type, quantity, and value of products which should be manufactured; type, number, and cost of tools, equipment and machinery required; and size, location, and cost of floor space for modernized or expanded plant and production facilities. *Walter Kidde Constructors, Inc., Dept. CE, 140 Cedar St., N. Y. 6.*

CENTRIFUGAL PUMPS — Wide interchangeability of parts for Class CN-TA multi-stage centrifugal pumps is featured in a 2-page foldout chart in bulletin 7251, 18-pages. Cutaway and dimensional drawings show how the design of these units makes them specifics for boiler feed, refinery, process work, and mine pumping at pressures above 300 psi. *Ingersoll-Rand Co., 11 Broadway, N. Y. 4.*

SYNCHRONOUS MOTORS, their operation, and control are described in 16-page bulletin GEA-5873. Problems common to synchronous motor applications and their solution by using the correct control equipment are explained in a question-answer technique. *General Electric Co., Dept. CE, Schenectady 5, N. Y.*

PHOTOGRAPHIC MATERIALS—Up-to-date data and information on the characteristics of Kodagraph reproduction materials for use in engineering and industrial fields are

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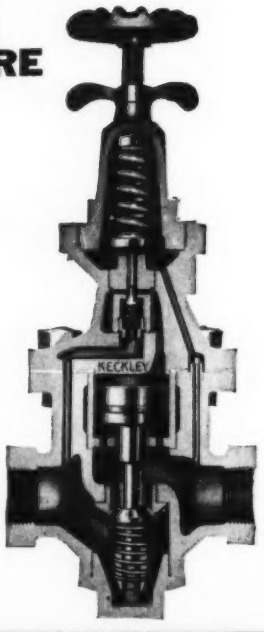

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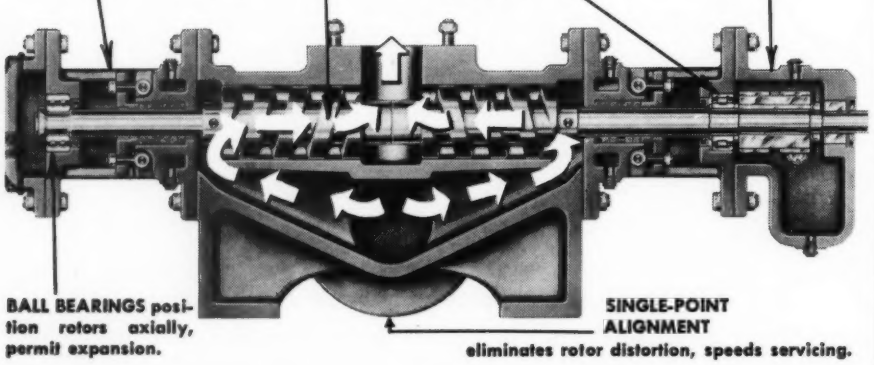

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BOOKLETS —Starts on page 74

provided by a new edition of "Modern Drawing and Document Reproduction." Sections on Kodagraph projection positive paper and microprint paper have been added to the 23-page booklet along with the latest data on sheet sizes, roll sizes, and packings. *Ind. Sales Div., Dept. CE, Eastman Kodak Co., Rochester 4, N.Y.*

INSULATION — Eight-page illustrated brochure of design and engineering data on Insulite industrial insulation board includes engineering data on fabrication, design factors, physical properties, and thermal conductivity of the fiber board insulating material. A section is devoted to fabrication ideas for designers with illustrations showing the materials' wide range of uses. Styled to fit neatly in a file drawer, with file tab attached, the brochure also deals with specialized uses of the product. *Insulate, Dept. CE, Minneapolis 2, Minn.*

VAPORSEALS — Complete recommendations for vaporsealing insulation on low temperature vessels are given in an 80-page, bound volume entitled "Vapor and Weather Barriers for Low Temperature Installations." It contains fifty-four illustrations showing exactly where and how a vaporseal coating should be applied over the three major classes of thermal insulation. *The Insul-Mastic Corp. of America, Dept. CE, 1141 Oliver Bldg., Pittsburgh 22, Pa.*

NICKEL-CHROME — Engineering data bulletin 1 on HR-3 (37 percent Ni-17 percent Cr) cast alloy is for reference use by designers and engineers concerned with parts subject to corrosive elements and high temperatures. It gives complete data on chemical composition, physical properties, mechanical properties, heat and corrosion resistant properties, recommended design stresses, heat treatment, machinability, and weldability. *Standard Alloy Co., Inc., Dept. CE, 1679 Collamer Rd., Cleveland 10, Ohio.*

HOT WATER CONTROLS — Bulletin F6167, 8 pages, is intended as an aid to engineers, architects, and contractors in applying electronic outdoor reset hot water controls, whether the application is a small zone requiring a refinement in controls, or a large commercial installation involving a multiplicity of zones and requirements. It also contains information concerning the use of an optional night depression with morning warm-up. *Barber-Colman Co., Dept. CE, Rockford, Ill.*

consulting engineers' calendar

Date	Sponsor	Event	Location
Jan. 18	American Institute of Consulting Engineers	Annual Meeting	Engineers Club New York, N. Y.
Jan. 18-22	American Institute of Electrical Engineers	Winter Meeting	Statler Hotel New York, N. Y.
Jan. 24-27	American Society of Heating and Ventilating Engineers	60th Annual Meeting	Rice Hotel Houston, Texas
Jan. 25-28	Plant Maintenance & Engineering Show	Exposition	Conrad Hilton Hotel Chicago, Ill.
Feb. 3	American Institute of Consulting Engineers	Monthly Meeting	Engineers Club New York, N. Y.
Feb. 4	Instrument Society of America	Regional Conference	Hotel Statler New York, N. Y.
Feb. 15-19	American Society of Civil Engineers	Convention	Biltmore Hotel Atlanta, Ga.
March 7-10	American Institute of Chemical Engineers	Meeting	Hotel Statler Washington, D. C.
March 10-12	American Society of Mechanical Engineers	International Meeting	Del Prado Hotel Mexico, D. F.
March 15-19	National Association of Corrosion Engineers	10th Annual Conferences	Muehlebach Hotel Kansas City, Mo.
April 15-19	American Institute of Electrical Engineers	Southern Textile Conference	Georgia Tech. Atlanta, Ga.
April 26-30	American Society of Tool Engineers	Industrial Exposition	Convention Center Philadelphia, Pa.
April 27	Association of Consulting Chemist and Chemical Engineers	Symposium-Banquet	Hotel Belmont Plaza New York, N. Y.
May 4-7	American Welding Society	Spring Meeting	Hotel Statler Buffalo, N. Y.
May 10-12	Compressed Air and Gas Institute	Spring Meeting	The Homestead Hot Springs, Va.
May 16-19	American Institute of Chemical Engineers	Summer Meeting	Springfield, Mass.
May 17-20	Basic Materials Exposition and Conference	2nd Annual Exposition	Amphitheater Chicago, Ill.
May 23-28	American Water Works Association	National Convention	Seattle, Wash.
July 13-15	Western Plant Maintenance Show	Conference and Exposition	Pan Pacific Bldg. Los Angeles, Calif.

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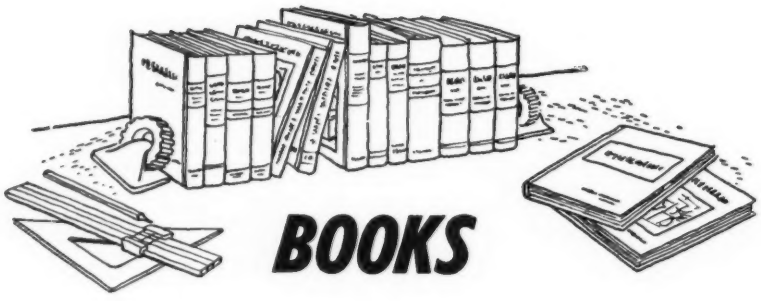

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AN INTRODUCTION TO POWER SYSTEM ANALYSIS, by Frederick S. Rothe; John Wiley and Sons, Inc. 243 pages, $5.00.

Reviewed by William C. Sealey
Chief Engineer
Transformer Department
Allis-Chalmers Mfg. Co.

This book provides the fundamental mathematics required for the solution of problems involving power systems under normal and fault conditions. The mathematics of each of the following components are considered separately: the transformer, the generator, the transmission line, and the combination of these separate components under various load and fault conditions. Sufficient explanation is provided so the book can serve as a text to teach the fundamental mathematical relations. Because of its conciseness it may be used as a reference for the mathematical relations when they are needed.

Sufficient numerical examples are included to illustrate the application of the mathematical relations to practical problems.

Equivalent circuits in general and the common equivalent circuits used for transformers are described. This is followed by the fundamentals of symmetrical components and their equivalent circuits, plus the mathematical relations and the equivalent circuits for synchronous and induction machines.

Relations are obtained for sudden application of faults and suddenly applied system loads.

The mathematics involved in determining the sequence impedances of overhead transmission lines are presented together with their derivations. Separate chapters are presented on steady-state transmission line theory and the fundamentals of power system stability.

The usefulness of the book is increased by its conciseness in presenting the mathematical relations. The material is presented in a simple, straightforward manner. It provides a general view of the overall problems of current and voltage relations in power systems, together with the mathematics necessary for the solution of the basic problems usually encountered.

TEMPERATURE MEASUREMENT IN ENGINEERING, by Dean Baker, E. A. Ryder, and N. H. Baker; John Wiley & Sons, Inc., 179 pages, $3.75.

Reviewed by Frederic E. Hessey
Supervisor, Engineering Dept.
Minneapolis-Honeywell Regulator Company

The scope of this book is limited to the measurement of internal temperatures and temperature gradients of solids. The subject is well covered, both as to the principles of thermocouple thermometry and as to the practical application to internal temperatures in solids. The numerous references readily enable the reader to delve further into any phase of the subject which may be of specific importance to his problem.

The first seven chapters deal with the basic theory of temperature measurement with thermocouples and include techniques for calculating designs for test thermocouples

and their installations. The chapters are written in a manner best understood by one with some technical training. Readers unfamiliar with thermocouple thermometry may find it necessary to use some of the reference material in order to arrive at a clear understanding of the subject. However, for those already familiar with the fundamentals, the scope and presentation of the material in the book will be helpful.

The last five chapters cover thermocouple types for measurements of temperatures in solids, drilling techniques, installation designs, plus special material for supporting, insulating, and installing test thermocouples. This part of the book is quite comprehensive and complete in itself. It will be readily understood by anyone with some mechanical skill and could be successfully used as a guide by a machinist or model maker.

The chapter on design types will be especially valuable to the project engineer. It shows many methods of installation and design from which he will be able to select that type most suitable for his needs. Extensive references in this chapter in particular identify the source and applications of the designs, enabling the reader to look up specific performance data.

The subject matter is well supported by numerous illustrations which are clear and understandable. The book is unique in that it covers the field of internal temperature measurements in solids, especially the practical application of such measurements; yet it provides ample references which allow the reader to extend his search for further detailed information in any desired direction. It is a valuable book for the library of the engineer or engineering department concerned with the measurement of temperatures and temperature gradients in solid materials. It should be of special interest to those engaged in engine testing, from which work much of the material was gathered.

ALSO AVAILABLE

SCIENTIFIC RESEARCH AND DEVELOPMENT IN AMERICAN INDUSTRY—A Study of Manpower and Costs, Bulletin No. 1148, Bureau of Labor Statistics, 106 pages, $.50. This is a comprehensive and detailed report on the nation's industrial research resources. Nearly 2000 companies, with about 6½ million employees and sales totaling nearly $100 billion in 1951, were studied. Their scientific and engineering research programs cost almost $2 billion in 1951—about 85 percent of the total national cost of industrial research and development. In addition to 96,000 engineers and scientists, their research staffs included 143,000 supporting workers.

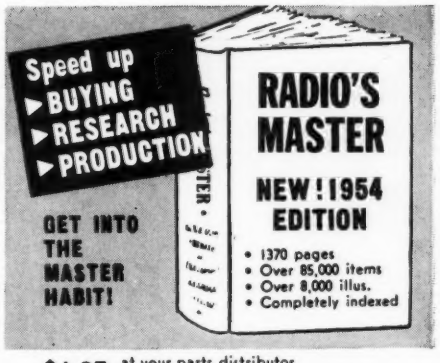
BETZ HANDBOOK OF INDUSTRIAL WATER CONDITIONING—Fourth edition, W. H. & L. D. Betz, 250 pages, $3.00. This volume offers a practical up-to-date text for reference or study. The introductory chapters deal with basic water treatment processes such as aeration, coagulation, and softening. Following chapters are concerned with specific water problems, particularly problems encountered in boiler water and cooling water conditioning. Applications and limitations of various water-treating equipment and methods are covered in detail. To guide engineers and chemists in supervising water conditioning operations, a supplementary section is devoted to control water analyses and their interpretation.

THE MEANING OF THE CONGRESSIONAL HEARINGS ON ATOMIC ENERGY, Atomic Industrial Forum, 80 pages, $1.00. This is a report of a panel discussion by seven experts from industry, labor, science, and the legal profession.

FILMS

"FOUR EXPERIMENTS IN HYDRAULICS" National Bureau of Standards, sound and color, 16 mm, 16 minutes. A technical film available on loan to groups having specific interest in hydraulics research. The film describes the general features of four hydraulics experiments which deal with the damping of standard waves, dam-break waves, diffusion of jets, and density currents.

"WELDING ADVANCES WITH ALUMINUM," sound and color, 16 mm, 28 minutes. A comprehensive description of welding aluminum using both the tungsten arc and consumable electrode methods. Illustrations of the use of these inert gas methods are presented to demonstrate some of the many jobs they have simplified in manual, automatic, and semi-automatic welding of aluminum. These include pressure vessel welds, weld repair of castings, and the production of weldments.



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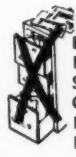

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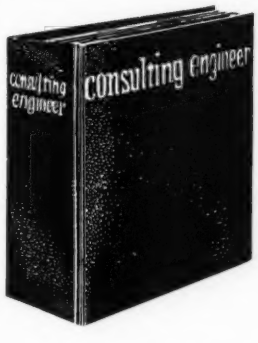

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